RAILROAD GAZETTE

FRIDAY, MARCH 13, 1903.

CONTENTS

The office of the Railroad Gazette is now at 83 FULTON STREET, at the corner of Gold Street, east of Broadway.

Contributions

The Big Bend Tunnel.

Roanoke, Va., March 3, 1903.

TO THE EDITOR OF THE RAILROAD GAZETTE:

We note in your issue of February 20 a description of the ventilating plant completed at Big Bend Tunnel, on the Chesapeake & Ohio Railway, and that no reference is made therein to the contractors, Messrs. B. F. Sturtevant Company, who installed the plant, or to their able representative, Mr. H. S. Grigsby, of Atlanta, Ga. As these gentlemen rendered efficient aid in elaborating the plans for this work, as well as conducted its installation, will you not kindly publish this letter so that they may receive due credit?

CHAS. S. CHURCHILL,
C. C. WENTWORTH.

Trouble in Shrinking Driving Wheel Tires.

Central of Georgia Railway Company,
Savannah, Ga., Feb. 27, 1903.

TO THE EDITOR OF THE RAILROAD GAZETTE:

We recently changed tires on a few consolidation engines having 21 in. x 32 in. cylinders, and weighing 196,000 lbs. Previous to the change the engines were in service about a year, riding easy and comfortable, and in every way satisfactory. After changing tires they were rough, uncomfortable, and quite unsatisfactory in their performance. Examination showed no cause, so it was decided to test the wheels, and they were found to be out of round. This can only be accounted for by the shrinkage having more effect on the open half of the wheel; the opposite half being almost solid with the counterbalance.

After placing the wheels in the lathe and turning them true, the engines worked as formerly, riding easy and comfortable. This is the first case where we have discovered this effect in changing tires without turning them after being shrunk upon the centers. I mention this in the hope that I may be enlightened by those who may have had similar experience and possibly have found a remedy other than turning the tires on the centers in all cases after re-tiring. It has proved to be a very convenient and speedy method to turn the tires independently, replacing the worn ones while the wheels remain under the locomotives. Previous to the above experience we had only cast-iron centers, while the difficulty we have discovered was with cast-steel centers. THEO. D. KLINE.

[It well may be that some differences of opinion may be found among motive power officers as to the cause of Mr. Kline's trouble, but our own notion is that the trouble was most likely caused by the eccentricity of the tire. That is to say, every point in the circumference of the tread is not equi-distant from the fit on the wheel center. It is general practice on many roads to turn both the inside and outside of every new tire, otherwise it is almost impossible to prevent eccentricity. We do not know the character of the machine on which the boring in this case was done, but we might suggest that a possible cause of error may be due to the non-rigidity of the lathe.—EDITOR.]

The Comparative Wear of Heavy and of Light Rails.

Sparrow's Point, Md., Feb. 20, 1903.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In an editorial of Jan. 30, 1903, "Concerning the Rail Situation," you state as a "matter of general knowledge," that the railroads "do not get service enough to compensate for the money paid for the additional weight," in the heavy sections. While this is true in some instances I believe that a sweeping statement of this kind, from such a source, does the heavier rails an injustice in a great many cases, to one of which I wish to call your attention in this short article.

If service were all that is to be gained, by heavier rails, then this complaint of the railroads is well grounded, but very often they lose sight of the fact that the extra metal of the heavier sections does not, in a great many cases, to one of which I wish to call your at- the wear comes, and hence increased weight does not

Fig. 1.—Sections of 68lb. and 80lb. Rail.

Table No. 1.—Comparison of 68-lb. and 80-lb. Rails.

	Areas.		
Weight.	Head.	Web.	Flange.
68-lb.	3.20	1.261	2.229
80-lb.	3.30	1.615	2.910

	Heights.			
Weight.	Head.	Web.	Flange.	Radius of upper fillet.
68-lb.	1 35/64	2 3/16	49/64	½
80-lb.	1½	2⅝	⅞	5/16

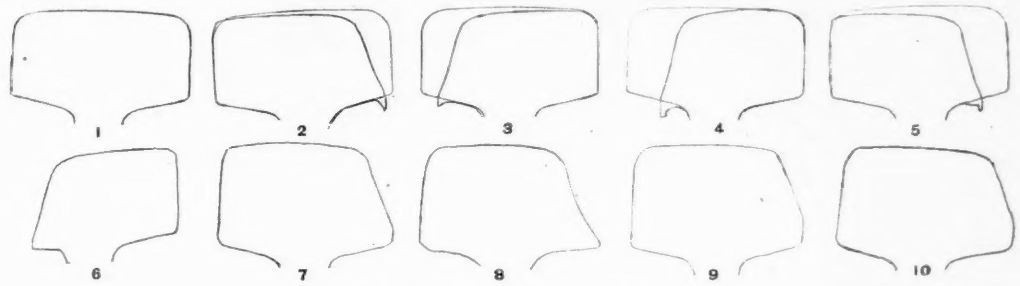


Fig. 2—Sections of Worn Rails.

TABLE NO. 2.—WEAR OF RAILS.

No.	Reduction of area in head.	Loss in pounds. Per yd.	Weight of rail. Lbs.	Loss. Per cent.	Approximate tonnage.	Loss per yd. per 10,000,000 tons.	Alignment of track.	Time in track.
1	0.015	0.153	80	0.19	15,000,000	0.102	Tangent	28 months
2	0.490	5.000	80	6.25	19,821,400	2.522	4 deg. curve	37 "
3	0.610	6.220	80	7.78	19,821,400	3.139	5½ deg. curve	37 "
4	0.850	8.660	80	10.83	19,821,400	4,374	6 deg. curve	37 "
5	0.900	9.170	80	11.47	19,821,400	4.631	6½ deg. curve	37 "
6	0.890	9.070	80	11.34	15,535,700	5.843	7½ deg. curve	29 "
7	0.470	4.790	85	5.64	Not known	....	15 deg. curve	7 "
8	0.600	6.110	85	7.19	Not known	....	15 deg. curve	7 "
9	0.410	4.180	85	4.92	Not known	....	15 deg. curve	7 "
10	0.410	4.180	85	4.92	Not known	....	15 deg. curve	7 "

necessarily mean increased life of rail. This was very forcibly brought to my attention, a short time ago, by the complaint of a railroad that their heavy rails were not giving them any better service than their old light rails. I had the pleasure of personally investigating this complaint, which was in this case based on the claim that they were not getting any more service from their 80-lb. rails than their 68-lb. rails.

Fig. 1 and its accompanying table tell very forcibly why the 68-lb. rail wore as well as the 80-lb. rail.

On referring to the table we find that while the 80-lb. rail has 12 lbs. more of metal in it per yard, the head has only a little over one pound more of metal in it than the lighter rail. Knowing this, could the railroad reasonably expect increased wear? This is no exceptional case, being a matter of common experience in a majority of the complaints against the so-called heavy sections, and when increased weight has meant a corresponding increase of metal in the head, there has been very little just cause of complaint.

While it is not my desire to discuss rail sections, it is entirely in the scope of this article to point out the influence that the shape of these two heads had on their wear. The 68-lb. rail having a deeper head, and larger radius of the upper fillet offered more resistance to wear. This is more readily seen when we appreciate how a rail wears on curves, and it is on these that we have all our complaints, it being the exception to hear any complaints against rails on tangents. On curves the rail wears to such an extent that they take the radius of the fillet on the flange of the wheel, and hence it would seem that ½ in. radius would mean less wear, to the side of the rail, than the $^5/_{16}$ in. radius of the 80-lb. rail.

From the above, I think, I am justified in saying that a great deal of the disappointment felt, by some, in the heavy section, is very often due to the lack of appreciation of the simple fact that putting down heavier rails, or in this case 80-lb., rails, could not mean any more wear, but only meant that the 80-lb. rail was more of a girder, thus increasing the strength of the rail, and making a better roadbed.

In my inspection of rails that have been complained of as not wearing well, I have invariably found them on curves running from 4 deg. to 15 deg., and where the tonnages have been the same I have found that the greater wear is always on the sharper curve. This is very clearly brought out by the accompanying diagrams, of rails now in track, all of which were taken by a "rail indicator." In Fig. 2, diagrams 1 to 6, inclusive, were taken on rails from the same mill, the others coming from different mills.

SIMON S. MARTIN.

Electric Interlocking at the Lake Shore-Rock Island Terminal.

[WITH AN INSET.]

The Taylor Signal Co., Buffalo, N. Y., has taken the contract for making and installing the switches and signals at the new and enlarged passenger terminal of the Lake Shore & Michigan Southern and the Chicago, Rock Island & Pacific Railroads, at Chicago. The apparatus is to be the Taylor "all-electric" and a diagram of the yard is shown on an inset accompanying this issue. It will be seen that the number of functions is large. The most distant switch is over 2,000 ft. from the cabin, and there are slip switches more than 800 ft. away.

The total number of functions provided for in the machine is 169; there are 192 spaces and 133 levers. Ten of these levers are for high signals, 75 for dwarf signals, 46 for switches and two for two scotch blocks. The signals inside the train shed are supported from the roof, but each stands on its own base. There is a footway leading to all these shed signals. The caution signals governing inward movements, at the outer end of the train shed, are operated by track circuits flowing through the rails within the shed.

The contract shows that the motors at the switches and signals are worked by currents from Willard storage batteries, there being 55 cells of 160 ampere hours each. A generator of 3 k.w. capacity, situated in the power house of the Lake Shore road, beneath the tracks, at Harrison street, supplies the current to charge the storage battery. Both generator and batteries are provided in duplicate, so that all functions can be performed by either set alone. All of the semaphores are lit by electric lights of 4 c.p. each, arranged in multiple. On the signals the lamps are enclosed in Adams & Westlake round-body steel semaphore lamps. The circuits for lighting the semaphores are divided into three sections, each serving a defined part of the yard. The light circuit is independent of the switch and signal circuit. Track circuits are provided for the protection of all switches and derailing switches south of Stowell street. Track relays are provided with a screw hand-release, like that used on the Chicago, Milwaukee & St. Paul for electric locking. The track relays have large, blunt carbon points opening ½ in. Gravity batteries are

used for track circuits. The rails through which circuits are run are bonded with two wires, and at the ends of circuits 24-in. Weber insulated joints are used. The battery chutes are of iron, 7 ft. deep and 10 in. inside diameter. The signal posts are of iron tubes and, with the fittings, conform to the Lake Shore road's standard. The semaphores are designed for a movement of 60 deg., with "continuous light" spectacles with three openings. The semaphore blades will be of iron, No. 18 gage, with enamel colors.

The cabin is 15 ft. x 40 ft. and three stories high. The first story is 8 ft. between joints and the second is 6 ft. 6 in. On this floor the batteries are kept. The third floor, the operator's room, is 9 ft. high and has no ceiling, the sheathing being placed on the rafters. The building is of brick to the top of the second story and above this is covered with corrugated galvanized iron. The floor of the first story is of cement and that of the third has steel beams to support the machine.

Improvements on the Pennsylvania Railroad.

BY S. WHINERY, C.E.

Among American railroads the Pennsylvania has always occupied, in the public mind, a front rank in the matter of superior construction, broad policy, and able management. For a whole generation it has furnished the model and set the pace for American railroad practice. Its policy during all that time constantly and consistently has been to spend money freely to increase the earning power of its properties and to improve its service to the public. The results have fully justified the faith and far-seeing sagacity of its management, and confirmed the wisdom of the policy. It is not surprising, therefore, to find that at no period in the history of the company have improvements been projected and vigorously carried out upon a scale so vast and bold as at present. So quietly and so rapidly have these great projects been planned and entered upon that the busy railroad man has hardly been able to keep pace with them, or to realize their magnitude and importance as a whole.

The development and growth of the railroad transportation business in this country has been so rapid and so stupendous that even the Pennsylvania Railroad, noted as it is for far-sighted provision for the future, has been scarcely able to keep abreast of the rising tide.

Along with the great growth of the passenger business has arisen a demand for speed and comfort which the company has made every effort to meet, and the extensive rectification of the alinement, which will be partially described, has had, as one of its objects, the meeting in the most liberal manner of this demand.

It is, however, the phenomenal development of the freight business in the last few years that has presented the most difficult and perplexing problems for the management, and it is for the solution of these problems principally, that many of the present improvements and extensions are being pushed to completion with the utmost vigor. One of the most troublesome incidents of the present freight situation is the congestion of tracks and yards in the large cities through which the main lines of the Pennsylvania pass. In these cities the yard and track capacity, notwithstanding the liberal scale on which it had been provided, has been found inadequate, and the conditions are such that it is found almost impossible to secure room within the cities for such extensive enlargements as the business now demands, and attention is being given to plans for carrying through freights around rather than through some of these cities. This is notably the case at Pittsburg, Harrisburg and Philadelphia, as will be described later. The problems relating to the handling of both freight and passenger business in the great cities of Philadelphia and New York are being worked out with a degree of thoroughness and completeness, and upon a scale unheard of heretofore in the railroad world.

It is purposed in this article to outline briefly some of the more important of the improvements in progress, as well as those made within the last few years and those projected and intended to be carried out in the near future, the general plans for which are now practically completed. In doing this, it will be convenient to begin at Pittsburg and proceed eastward, along the main line, to New York.

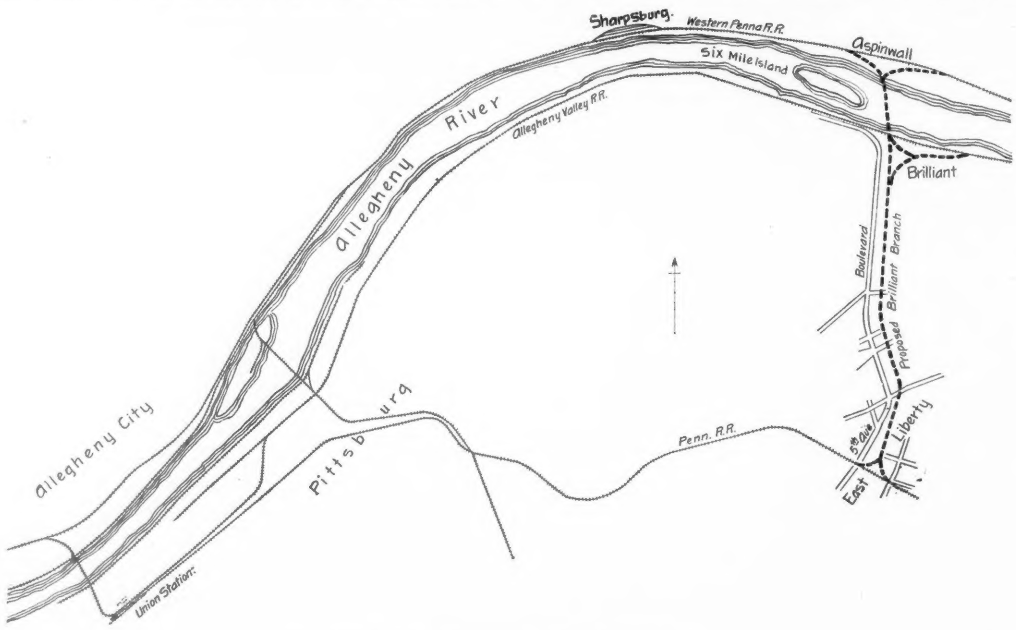
The improvements in the city of Pittsburg, completed about a year since, have been fairly well described in the railroad periodicals, and need not be dwelt upon in detail here. A magnificent modern Union Station has been erected, and the great yard just east of this station, as well as the main line through the city, has been completely remodeled and rebuilt, including the elevation of the tracks, so as to avoid many street grade crossings.

Some idea of the extent and value of these improvements may be formed from the following data: The new Union Station with its train sheds has cost $2,185,526. A new power house was erected at a cost of over $250,000; there was expended in remodeling and raising the grade of the yard in the vicinity of the new station the sum of $832,035, and for the interlocking system in this yard, $95,139. The total expenditures for improvements in Allegheny County (most of which was expended in the city of Pittsburg) during the five years ending with December 31, 1901, was over $4,600,000.

In addition to these improvements, already completed, it is planned to build a very commodious freight station at the extreme western point of the city of Pittsburg, on the site of the historic Fort Duquesne, for the better and more prompt handling of Pittsburg local freights. This portion of the city is now reached by surface tracks down Liberty street which it is purposed to abandon. A new double track elevated road will be built down Duquesne Way along the south bank of the Allegheny river, from the main line near where it crosses the river to the new freight station at Duquesne Point, referred to above. The elevated structure will be over one mile long. This improvement is estimated to cost about two million dollars. When completed it will not only be of great benefit to the shipping interests of the city, but will largely relieve the present troublesome congestion of the local freight business in Pittsburg.

From Pittsburg the Pennsylvania lines spread out fan-like to the west, the northwest, and the north, with the result that all the business of these lines between the east and the west is concentrated into a great vortex at Pittsburg. These conditions early produced a state of congestion at that point which it was absolutely necessary to relieve. The remedy decided upon was to carry through freights *around* Pittsburg rather than through the city. In pursuance of this plan a connection was some time since completed around the south side of the city by way of the bridge over the Ohio river at Brunot's Island, and of the Pittsburgh, Virginia & Charleston Railroad up the Monongahela Valley, and to the main line at East Liberty. This, while offering great relief, has not proved adequate to the demands of the situation.

It is therefore proposed to provide another connection around the city over which through freights may be carried without passing through the greatly congested yards in the heart of the city. Contracts have been let for the construction of a new line from East Liberty northward to and crossing the Allegheny river, connecting with the Allegheny Valley road at Brilliant on the south side, and with the Western Pennsylvania Railroad at Aspenwall on the north side of the river.



The "Brilliant" Connection Around Pittsburg.

The distance from East Liberty to the river is something more than two miles, but the new line with its various connections will require more than four miles of new construction. It will be four tracked throughout.

The Allegheny river will be crossed by a steel bridge about 1,200 feet long having one channel span of 500 ft. and two spans of 200 ft., the balance being plate girder construction. The clear space under the bridge at high water will be about 60 ft. The total cost of this improvement will be about two million dollars. Fig. 1 shows this improvement in outline.

In connection with this new line it is proposed to build and equip a very extensive freight station and yard at Sharpsburg, which is estimated to cost, exclusive of real estate, at least one million dollars. Extensive yards will also be built at the connection of this new line with the Allegheny Valley road, and a new yard built at East Liberty for the further accommodation of Pittsburg local freight.

With these improvements completed a large part of the through freight will be moved from Allegheny City along the north bank of the river to Sharpsburg, where necessary reclassification will be made in the Sharpsburg yard, and it will then be forwarded to Aspenwall, and over the new connecting road to the main line at East Liberty.

With the completion of this Brilliant connection the Pennsylvania Railroad will have a complete belt line around the city of Pittsburg. It may be noted here in connection with this Brilliant extension that the Western Pennsylvania Railroad from Pittsburg to its junction with the main line at Bolliver, 58½ miles east of Pittsburg, is to be improved by reducing its eastbound grades to 15.8 ft. per mile and the double track extended over the whole distance. This will provide an alternative low-grade freight line from Pittsburg eastward.

Without undertaking to notice all the numerous changes in alinement and grade that have been made or are in progress on the main line between Pittsburg and Philadelphia, the following may be noted:

The rapid growth of the residence and manufacturing suburbs east of Pittsburg has created a large number of street crossings at grade, and it is intended to get rid of these as rapidly as possible. The work of eliminating these grade crossings through Wilkinsburg and through Swissvale will be proceeded with at once. The magnitude of the work is indicated by the estimated cost, which is $576,000.

At Irwin, twenty-two miles east of Pittsburg, a change of alinement has been made nearly two miles in length by which the distance is shortened 1,000 ft. A uniform thirty-three-minute curve for the whole distance is substituted for three curves, one of six degrees, one of four degrees, and the other of five degrees. At the same time the gradients were materially reduced and the track elevated to avoid grade crossings of streets. The grading for the new line was heavy and expensive, and the new right of way costly.

Beginning at Radebaugh, 29 miles east of Pittsburg, a new low-grade freight line will be built to Millwood on the main line, 46 miles east of Pittsburg, for the purpose of securing lighter grades and obviating the use of helping engines over this stretch. The new line will be about one and one-half miles longer than the present line, which will continue to be used for passenger service. The new line has been located, and construction will be begun this spring, and it is hoped to complete it within one year. The estimated cost of this new line will be about seven million dollars.

Just west of Latrobe, 40 miles east of Pittsburg, another change of location was made for a distance of two miles by which six curves varying from 5 deg. to 50 min. were thrown out and a long compound curve substituted, which, in its sharpest stretch, does not exceed a 54 min. curve. At the same time the distance was shortened one thousand feet and the gradients decreased. Following this change, the line was elevated sixteen feet through Latrobe, thus avoiding crossing six streets at grade. This changed line will become a part of the New Radebaugh-Millwood line, just described, though, being already completed, its cost is not included in the estimated cost of that line.

Just east of Millwood occurs a stretch of eight miles of road, passing through "Pack Saddle Gap," which, because of topographical and other difficulties, continues to have two tracks only. It is now intended to at once four-track this section and at the same time improve the alinement, at a cost of about $800,000.

Perhaps the most important and expensive changes of alinement that have been undertaken occur on the western slope of the Allegheny Mountain between Johnstown and Cresson. The whole character of the location has here been so changed as to make it practically a new line throughout.

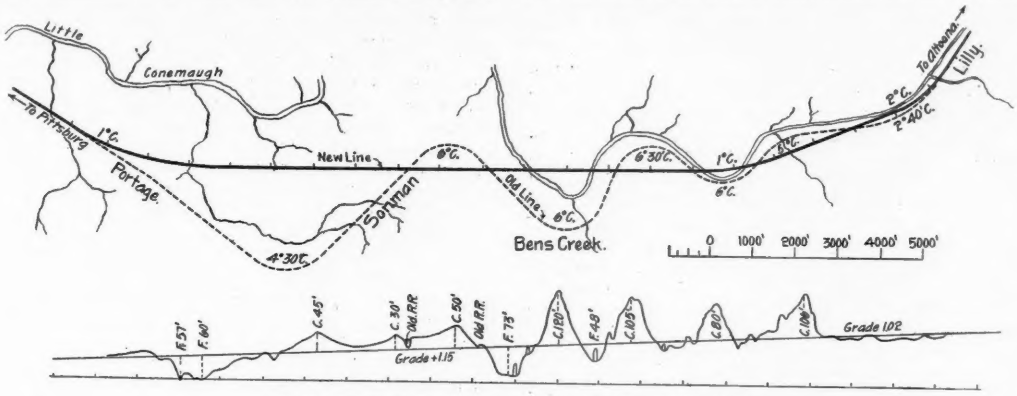
Between Summer Hill and Wilmore a new line has been located and constructed for a distance of about two and one-half miles, with a saving in distance over the old line of 1,800 ft. The old line, following closely the course of the Little Conemaugh river, was a succession of curves varying from 1½ to 5½ deg., while the new line has no curve exceeding one-half deg.

The elevations at the beginning and end of this change being fixed by the old line the gradient was slightly increased, but this was more than compensated by the great reduction in curvature.

The grading work on this new line was very heavy and expensive. One and a half million cubic yards of excavation and 29,000 cu. yds. of Arch Bridge masonry were required, and the cost of the whole improvement was about one million dollars. One remarkable feature of the work is an open cut of considerable length one hundred and sixty feet deep. This improvement was completed and put in service in October, 1902.

About three miles eastward from the end of the change

just described, begins another notable change of location which extends over a distance of about 4.1 miles. This change is shown in Fig. 2, and is a good illustration of the heroic treatment by the company of the rectification problems encountered at many points on the line of the road. Four thousand two hundred feet of distance was here saved; 574 deg. of curvature, most of it six degree curve, is replaced by 93 deg. of curvature, none of which exceeds two degree curve and the greater part of which is one degree curve. The profile shows the heavy work encountered. While the gradients were necessarily somewhat increased, it is found that the present grades offer



Rectification of P. R. R. Main Line, Lilly to Portage.

less resistance to train loads than did the old line with its sharp curves.

The most serious obstacle to be overcome by any railroad from Pittsburg to eastern tide-water is, of course, that great divide, the Allegheny Mountains. Steep grades cannot here be avoided.

The Pennsylvania Railroad ascends this divide from the eastward with maximum grades of 52.8 ft. per mile. It pierces the summit by a tunnel nearly three-quarters of a mile long and descends the eastern slope by way of the famous horse-shoe curve with a grade of one hundred feet per mile. The capacity of the three track tunnel has, of late years, become inadequate, and plans for increasing the capacity of the road in this locality were devised and carried out. The old State tunnel, some distance south of its own tunnel, was secured by the company, put in repair and enlarged to accommodate two tracks, and connected with the main line from its eastern end. From its western end a connection to the main line at Cresson was constructed. The combined capacity of the two tunnels was found to be hardly sufficient, and it was decided to build still another single track tunnel alongside of the company's original tunnel, and parallel to it in both alinement and grade. This new tunnel will be 3,800 ft. long and will cost $475,000. The work is about half done, and it is hoped to have it in service within a year. When it is opened the company will have six tunnel tracks under the summit of the mountain at this point.

Together with the old State tunnel the Pennsylvania R. R. Co. secured the old right of way of the once famous Portage Railroad down the eastern slope of the mountain, and has proceeded to build a new double track road, with revised grades and alinement, from the tunnel to Hollidaysburg, a distance of seventeen miles. The grade on this line is lighter than on the main line, being 80 ft. per mile. This line in connection with the Petersburg branch, which will be double tracked, forms an independent route around Altoona, connecting again with the main line at Huntingdon, and with its lower grade up the mountain forms a valuable alternative route for westbound freight. The cost of the new road and of double tracking the Petersburg branch will be five million dollars.

At Newport, 20 miles west of Harrisburg, the location of the main line is to be changed during the present year for a distance of about two and a half miles to improve the alinement, decrease the curvature and dispense with thirteen street crossings at grade. The cost of this change is estimated at $450,000. In all there will be expended for improvements to the alinement in a stretch of five miles at Newport about one million dollars.

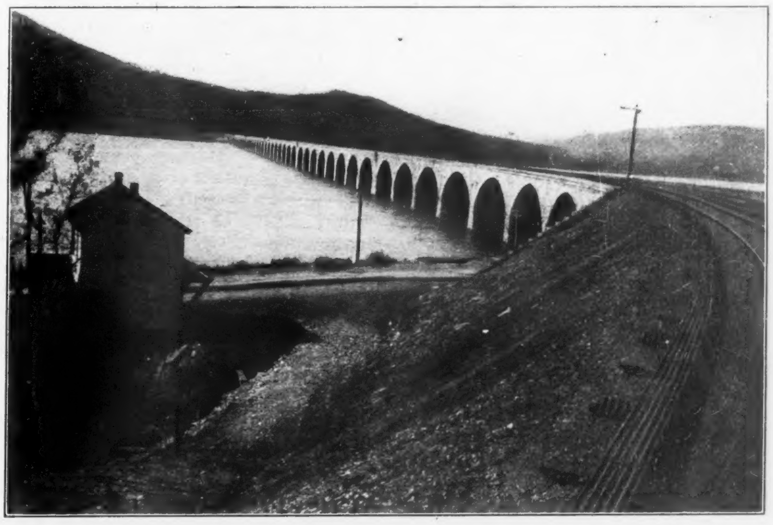
The improvements already made, and those either now under way or ready to be taken up at once in the vicinity of Harrisburg, are of the most important character and upon a very large scale.

The new stone arch bridge over the Susquehanna river at Rockville, 3,830 ft. long, was completed and put in service March 30, 1902. It furnishes a good example of the energy with which these great improvements are prosecuted. The bridge was opened for service two years and one day after the contractors began work. The bridge has forty-eight arches, each of seventy feet span, and its cost was within a few dollars of $1,000,000. Aside from its magnitude the bridge possesses engineering features of great interest. It is also notable as accentuating the present policy of the Pennsylvania Railroad to substitute masonry arches for steel spans wherever the conditions are favorable. The proposed new bridge below Harrisburg, and the new bridges over the Delaware at Trenton and over the Raritan at New Brunswick, N. J., both now approaching completion, are further illustrations of this policy.

During the construction of the Rockville bridge the Marysville yard, beginning at the west end of the bridge, was entirely remodeled and greatly enlarged. This being the junction of the main line with the Baltimore & Susquehanna division, provision was made to avoid grade crossings on the various main tracks by constructing over-head crossings and subways. A large quantity of grading was necessary to provide the requisite track room.

One of the most important new enterprises now proposed by the company is the building of a new low-grade double track freight line from Marysville to a point on the main line near Atglen, 58 miles east of Harrisburg. This line will pass around Harrisburg, on the opposite side of the Susquehanna river, and will avoid numerous eastbound gradients that now limit the weight of freight trains.

Leaving the main line at the western end of the great stone arch bridge, about six miles west of Harrisburg, the new road will follow down the west side of the Susquehanna river to a point about three miles below York Haven. Here it will cross to the left bank of the river upon a new stone arch bridge at an elevation of 62 ft. above low water in the river and 297 ft. above tidewater. It will then follow down the left or eastern bank of the river to a connection with the Columbia branch at Shock's Mill Station. From Shock's Mill Station a new line will be built down the center of the old Pennsylvania Canal property to Columbia and continued down the Columbia & Fort Deposit Railroad to a point near Cresswell. From Cresswell it will ascend the river hills with a maximum gradient of 15.8 ft. per mile, crossing Conestoga creek near its mouth at a height of 125 ft. above water surface, and crossing Pequa creek at Martic Forge, 110 ft. above the water. From Martic Forge the line will pass through or near the villages of Laurel Hill, Fairview and Quarryville to the junction with the main line at Atglen. The work will be of a very heavy character, as may be inferred from the estimated cost. The length of the new line from Marysville to Atglen will be about seventy-two miles, or about nine miles longer than the main line. No curves exceeding two degrees will be used on this line, and the maximum grade against eastbound business will be three-tenths of one per cent. The new road will be built in the most substantial manner, laid with 100-lb. rail, and equipped with the best appurtenances, including water troughs and a complete signal system.



P. R. R.—New Susquehanna River Stone Arch Bridge at Rockville, Pa.

Proceeding eastward on the main line the grades between Atglen and Thorndale, a distance of nine miles, will be reduced to the standard of three-tenths of one per cent., and a new line will be built from Thorndale to Paoli, a distance of fifteen miles, with connection, at Glen Loch, to the Trenton cut off, to improve the alinement and secure lighter grades. It is estimated that the cost of these new lines from Marysville to Paoli will be about twenty million dollars. The construction of this new low-grade freight line will be pushed with the vigor that characterizes all the work of the Pennsylvania Company, and it is expected that it will be completed and in service some time in 1904.

The present main line from Marysville to Atglen will, of course, be maintained and numerous improvements to it will continue to be made.

The changes that have been previously made in the alinement of the present main line between Harrisburg and Philadelphia illustrate in a remarkable manner the extent to which the company has gone in the improvement of its lines. This road was originally built by the State of Pennsylvania about 1849. In that early day the importance of good alinement was not realized, and it is said that the location of the line was largely dictated by the efforts of every small town to have the road reach its own doors, and these efforts were backed by such political influence as they were able to bring to bear in their favor. The result was a location more wonderful for its idiosyncrasies than for conformity to the present recognized principles of trunk line location.

The Pennsylvania Railroad Company began at an early day to rectify and improve the alinement of this part of its road. It is a remarkable fact that of the whole distance from Philadelphia to Harrisburg only one mile and a half of the line originally located and built upon, now remains in use, and this small remnant will be rebuilt during the present year to improve the grades over it. Among the more important changes recently made may be mentioned that at Elizabethtown, eighteen miles east of Harrisburg, where a new line, 2.27 miles long, almost the whole length of which is tangent, ending with twenty-seven degrees of two degree curve, replaces the old line 2.61 miles long having 273 deg. of curvature. Besides these advantages, the new line eliminate two important street grade crossings. This change was made at a total cost of about $344,000.

Another important change was made between Glenloch and Woodbine, where the present line crosses the original line sixteen times, and where, within a distance of five and one-half miles 302 deg. of curvature was thrown out: and, although the grade was necessarily increased five feet per mile, it is found that the decreased resistance from curvature enables freight engines to haul five more loaded cars over this part of the road. The character and extent of the changes and improvements that have been made in the alinement between Harrisburg and Philadelphia may be realized when it is stated that the aggregate curvature has been reduced 4,150 deg., an amount equal to nearly eleven and one-half complete circles.

We must return now to the vicinity of Harrisburg to note another improvement of great importance. The enormous quantities of soft coal carried by the Pennsylvania road from the mines between Pittsburg and Johnstown constitutes a business which in itself demands the special attention of the company.

The loaded cars picked up at each mine may be consigned to many different destinations, and it becomes necessary, at some point, to assort them as much as possible into train loads all for one destination. This is true also of other kinds of freight. To provide for this assortment a great freight station and yard has been planned, and is now under construction, in connection with the new low-grade freight line, at West Fairview, on the west side of the Susquehanna river about a mile below Marysville. This point will then become the terminal for freight trains of the Middle, the Philadelphia, and the Baltimore & Susquehanna divisions. Here will be constructed one of the largest and most complete freight yards in the world. There will be separate yards for eastbound and for westbound freight. Each will have an ample receiving yard and a great classification yard, with a capacity to make up simultaneously sixteen trains of one hundred cars each. The yards will be constructed to operate by gravity. There will also be ample roundhouses, repair shops for cars and engines, coal and water stations, and all the other equipments necessary to make it a small railroad world in itself. When it is added that the estimated cost is five million dollars, some conception of the magnitude of this single enterprise may be formed. It is expected that it will be completed during the year 1904.

We have now sketched briefly the more important improvements between Pittsburg and Philadelphia. Space will not permit even a mention of the great number of minor changes and improvements which in the aggregate have required a great deal of attention and have cost a large sum of money. Nor can we more than mention the large amount of third and fourth track added to the main line, and the extensions of sidings and yards at all the more important stations. Some idea of the extent of this character of work may be formed from the fact that during the year 1902 about eighty-six miles of new track was laid between Harrisburg and Pittsburg alone.

The effect of these changes and improvements, particu-

larly upon the eastbound freight business of the road, may be briefly outlined. Heretofore, and at present, the standard freight train en route from Pittsburg to Philadelphia is handled as follows: Owing to the heavy grades between Pittsburg and Derry, it is necessary to divide the train or use a helping engine over this part of the route. From Derry to Conemaugh at the western foot of the Allegheny range, a single engine can handle the train. A helper is then required to carry the train over the mountain summit. From Altoona to Columbia, 25 miles east of Harrisburg, the grades are such that one engine will handle the full train. Eastward from Columbia to Parksburg, a number of long grades of from 27 to 32 ft. per mile are encountered on the main line, and the train must be divided or helpers used. When the improvements above outlined are completed, a helper will be necessary at two points only; from Pittsburg to Radebaugh, a distance of nineteen miles, and over the Allegheny Mountain divide. From Altoona to Philadelphia and on to New York, a single engine will be able, without assistance, to haul trains of from eighty-five to one hundred loaded cars. What this means in capacity and economy of transportation need not be enlarged upon to the practical railroad man.

In the annual report of President Cassatt for the year 1902 just published the estimated cost of projected improvements between Pittsburg and Philadelphia, not including the work in progress and planned in the latter city, is stated to be fifty million five hundred thousand dollars. This is an enormous sum, so enormous that the mind can hardly realize its true magnitude, and the ordinary business man and possibly the ordinary stockholder finds it difficult to conceive how such a great additional investment can be made profitable. But it must be remembered that the magnitude of the business done by the road is also so colossal as to be almost incomprehensible to the mind. The statement that the Pennsylvania Railroad division handled, during the year 1902, 77,505,361 tons of freight and 24,605,597 passengers, can hardly be grasped by the human mind. Take the one item of fuel —coal and coke. The quantity handled as freight during the year was 41,722,988 tons. If this quantity of coal and coke were placed in a continuous pile one hundred feet wide and fifty feet high along the line of the road, it would extend more than sixty miles. If one end of the pile were at Philadelphia the other would be near Lancaster, Pa. The mind can only deal with such prodigious quantities by comparisons or by ratios and comparing the expenditures proposed with the immense results to be achieved, they do not seem disproportionate.

Referring to these and other proposed expenditures, President Cassatt in his annual report says: "While this is a large sum, no less an expenditure will enable your company to perform its duty to the public. Your board are satisfied that the investment of this amount will result in largely increased net earnings to your property, not only from the greater volume of traffic which will be handled, but through the economies which will result from the reduction of grades, the better location and arrangement of yards, and the saving in shifting service, now unduly expensive, and in overtime to train crews, which, owing to the overcrowding of yards and tracks, has become a serious item. While the amount of such savings cannot be estimated with positive accuracy, it is safe to say that in the handling of last year's tonnage upon the Lines East of Pittsburg they would have amounted to several millions of dollars."

All the work that has been described is in the nature of new improvements and extensions, and is exclusive of the enormous labor and expenditure required for "maintenance and renewal"—a work in itself that would seem sufficient to tax the energies of the management. This statement will be appreciated when it is recited that on the Pennsylvania Railroad division alone, with a mileage of 1,857.87 miles the expenditures on this account during the year 1902 were:

For maintenance of way and structures.	$7,784,825
" " equipment	11,622,136
A total of...........................	$19,406,961

Among the items which enter into the maintenance of way account, for renewals on that division were 45,633 tons of rail and 1,325,228 cross-ties—equal to a consumption of over five tons of rail and over 150 cross-ties for each and every hour during the year.

(To be Continued.)

New Zealand Railroads.

Engineering, in its issue of Feb. 20, quotes the report of the Hon. Sir J. G. Ward, Minister of the New Zealand Railways, in which he points out that the volume of traffic during the past year has been greater than in any previous year, showing an increase of £147,350, while the net profits are £22,961 higher. New locomotives, especially those for goods traffic, have a higher tractive power than those formerly used, and as a consequence 70-lb. rails are now being laid, so that the load traveling over them may be considerably increased. The indication of this result is the fact that while the number of locomotives has increased by 20 per cent., the available tractive power has gone up 38 per cent. The returns indicate a gratifying development of the resources of the country, and especially of the interior. The total revenue is £1,874,586, which is the highest ever reached, and the addition in ten years is over £750,000.

Although there have been heavier trains, the average revenue per train mile has slightly decreased. The expenditure per train mile has, however, been on the increase over a period of years, and the ratio of expenditure to revenue was last year higher than for the past 15 years. This increase was partly accounted for by increased expenditure on the maintenance of way, which for two years has averaged £196 per mile. Locomotive expenses per train mile have lately increased, which is, in part, due to reconstruction undertaken at the railroad works of the State. The length of railroad now open for traffic is 22,035 miles, and the capital cost per mile is about £8,159.

Railroad Shops.

BY WALTER G. BERG.*

General Classification.—In considering the general layout of a railroad shop system or discussing existing shops and methods, the most important point to keep clearly in mind is the distinctive features of shop systems, in other words, to establish a clear classification. If this is done, the entire subject can be handled and discussed systematically and valuable comparisons made.

Locomotive and car shops can be classed as manufacturing or repair plants. The Juniata shops of the Pennsylvania at Altoona is the only large railroad establishment in this country devoted exclusively to the building of locomotives. A number of railroads make all their freight cars, but the same shops are also used for car repairs. Generally speaking American railroad shops are primarily intended for repairs.

In the following discussion the subject will be treated particularly from the standpoint of large railroad repair plants. The aim has been to include the principal new plants erected since about 1890 and to briefly refer to older prominent plants which have been remodeled or extended during the last few years.

Railroad repair shops can be grouped in three principal classes, according to their size and location, viz.:

(a.) Local repair shops, usually at roundhouses, for making emergency repairs.

(b.) Division or general repair shops at division or junction yards.

(c.) Main repair shops at some central point with reference to the whole railroad system or a grand division of the same.

On small roads general repair shops having all the characteristics of division shops on a larger road are classed and serve as the main shop. The above classification is only correct for a large road.

In regard to the class of repairs, railroad repair shops can be grouped as follows:

(a.) Locomotive repair shops.

(b.) Passenger car repair shops.

(c.) Freight car repair shops.

In small plants of a large railroad and in the main plants of a small road these departments, while occupying separate quarters and kept, more or less, distinct from each other, are frequently combined in one shop or in a closely connected set of buildings. On larger roads the general tendency has been to establish large special shops for each class of work, or to have distinct sets of buildings grouped together and assigned to each class of work, with a clear distinction and separate control of the car and locomotive departments. The tendency is more towards a closer connection of the car and locomotive branches of repair shops, due no doubt to the fact that these two branches are generally merged and placed in charge of one official and the old separate departmental system abolished.

As a general proposition, it can be stated that the combination of locomotive and car shops in one plant, properly grouped, can be considered as good modern practice, where a suitable location and ample land and facilities are available.

There is no doubt that for heavy repairs to equipment the concentration of all such work in a large properly designed and equipped shop will be conducive to economy and speed of output. Whether it is desirable to carry this centralization scheme to such an extent as to possibly tie up the whole road in case of trouble with shop employees is a question that needs careful consideration. Railroad companies seem to prefer taking chances on the labor question and in the meanwhile derive all the benefits accruing from the shop concentration. Inquiry of a number of general motive power officers, on whose roads within recent years large central plants have been established, indicated that the labor question had been fully considered before adopting the centralization scheme, and that the benefits to be derived had outweighed the objections.

Selection of Location.—The location of large main repair shops for the entire system or for a grand division of a very large road should be made with a view to obtaining a good central location convenient to the several parts of the main line and branches. This central location need not necessarily be the geographical center, but it should be near the traffic center, in other words, where the largest number of engines concentrate or where it is most convenient for empty cars en route to be stopped for repairs.

The main source of supply of materials and the labor market are important elements. The cost of land and building materials and whether ample ground of suitable character and shape can be secured are important. State control of manufacturing plants and the tax rates may also influence the location.

*Chief Engineer of the Lehigh Valley.

Assuming the general locality to have been selected, then the prime consideration is to obtain ample ground to allow for future expansion. Further points to consider are the character of the foundations, the drainage of surface water, sewerage and sub-drainage, water supply, etc.

Evolution of General Ground Plan Layouts of Shop Systems.—The earliest railroad shop systems consisted of one or more main buildings reached by a yard approach, the tracks either running lengthwise through the building, which system is known as the longitudinal shop system, or with transverse dead end tracks in the building, known as the transverse or cross shop system.

The development of overhead traveling cranes allowed the introduction of the longitudinal locomotive erecting shop in which there are three tracks, the middle one serving for communication, and the two outside tracks for placing locomotives, two cranes being used to lift locomotives from the middle to the side track.

Similarly the introduction of overhead traveling cranes in cross locomotive erecting shops offered advantages in un-wheeling and re-wheeling a locomotive in place of using jacks, drop pits, or special staging with fixed hoists.

The most recent application of overhead traveling cranes in cross locomotive erecting shops consists in having one traveling crane heavy and high enough to lift the heaviest locomotive over other locomotives on the floor, in place of using a transfer table. This system was adopted by locomotive builders about 1890, but railroad companies did not make use of it until 1900. It is now in use at the locomotive erecting shops of the Philadelphia & Reading at Reading, Pa., and at the Lake Shore & Michigan Southern shops at Collinwood, Ohio. It is now being installed by the Pittsburgh & Lake Erie at McKees Rocks, Pa., and is also used in a modified form by the Pennsylvania at Altoona.

In regard to labor saving appliances for lifting heavy weights, the earlier installations used tackle and fixed cranes, also overhead trolleys, walking cranes and gantry cranes. The decade 1880 to 1890 might be classed as the educational period in demonstrating the advantages to be derived from pneumatic hoists and mechanical contrivances, and the decade from 1890 to 1900 as a similar educational period for bringing out the good and economical features of overhead traveling cranes. A shop is not considered up-to-date and equipped for economical work unless it has a full complement of overhead traveling cranes and pneumatic hoists throughout the shops and yards. It can also be reasonably predicted that conveying systems and electric or pneumatic switching engines will be gradually introduced extensively in the shop service.

In regard to the grouping of the buildings, in the early layouts the buildings had to be set close together so as to be mechanically shaft driven from engines as centrally located as possible, thereby cramping the layout, limiting the designer, and, in large plants, introducing separate power stations for each group of buildings.

During the decade from 1880 to 1890 the system of rope driving was introduced and considered as the possible permanent solution of the power question. Similarly pneumatic enthusiasts ventilated their doctrines freely and a number of manufacturing plants and some isolated railroad shops were operated by pneumatic power. From about 1885 to 1895 represents the period in which the application of electric power for shops, manufacturing, lighting and power plants made great strides. While electric power supply is still in the course of development, it can be safely stated that, more particularly with the direct current installations, the state of the art and the machinery and methods of application have been well exploited, tested and standardized, and the machinery can be obtained in the open market.

While polyphase systems have been successfully used and a number introduced in large railroad shops, this class of machines is still under the control of the two principal electric companies and competition is not as vigorous as in the direct current systems.

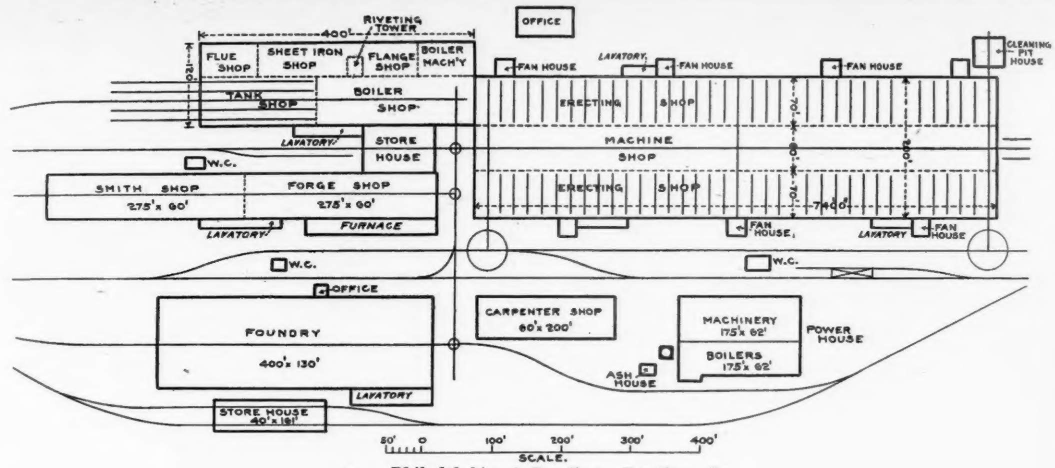
The tendency is to build heavier machine tools, adapted to higher speeds, with a larger range or variation of speed, and equipped with improved high grade tool steels.

From the above brief review it is apparent that the older shop plants of the country are laboring under serious disadvantages, and that even a number of plants, built from 1888 to 1892, will have to be classed as not strictly up-to-date.

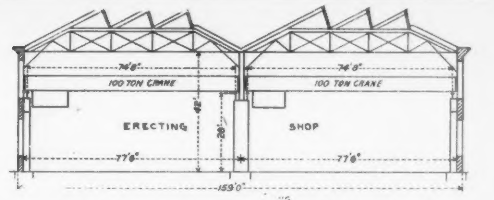
Heavy business, prosperous times, the introduction of heavy engines and cars, the lowering of rates and hence the pressure to reduce unit cost of all shop operations, all tend to emphasize the necessity of a railroad company introducing the very best appliances and methods. Manufacturing companies are 10 years ahead of the railroads in this respect, and, while manufacturing and repair work offer different problems in the detail conduct of the work, railroad companies will not lose by patterning after manufacturing plants.

Many railroad companies are looking into the question of improving and enlarging their shop facilities to meet the increased demands. For a number of years following the railroad depression, about 10 years ago, the companies did not make any important additions to their shop plants, and the absence of the regular yearly increment of shop improvements for a period of nearly 10 years is telling.

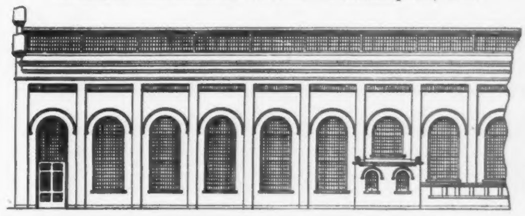
Furthermore, the new heavy power and cars are now beginning to be shopped, and it is becoming more apparent that the old shop facilities and methods are not

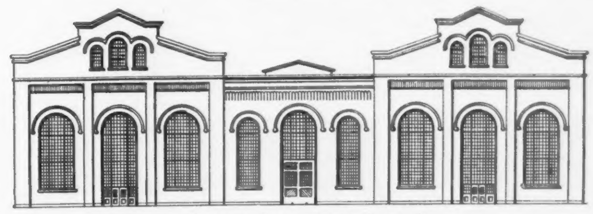


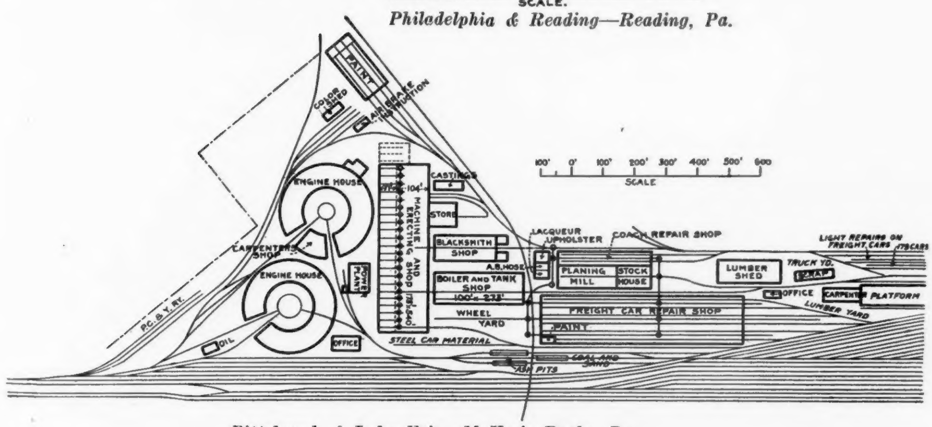
Philadelphia & Reading—Reading, Pa.



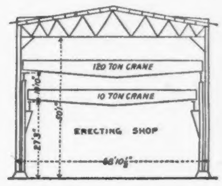
Baldwin Locomotive Works—Philadelphia, Pa.


Locomotive Shop—P. & R.

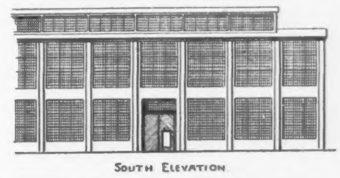

Locomotive Shop—P. & R.



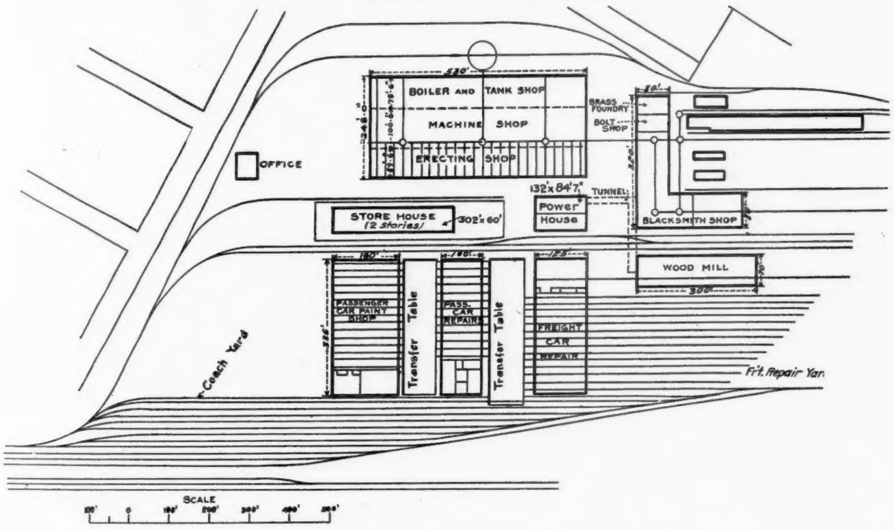
Pittsburgh & Lake Erie—McKee's Rocks, Pa.



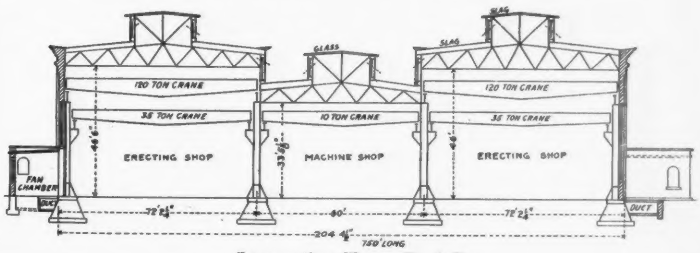
Brooks Locomotive Works—Dunkirk, N. Y.



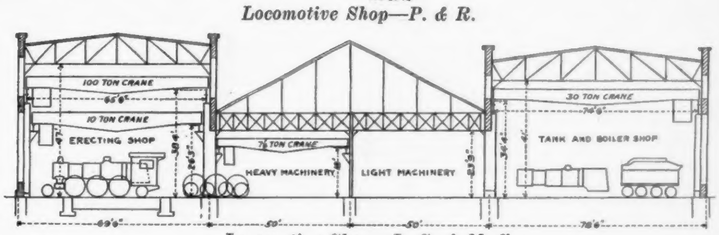
Brooks Locomotive Works—Carpenter Shop.



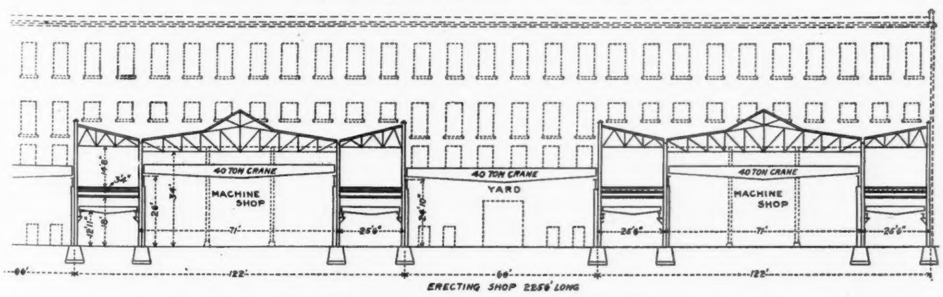
Lake Shore & Michigan Southern—Collinwood, Ohio.



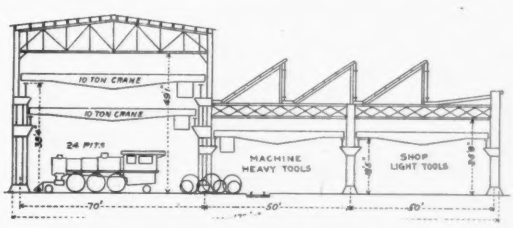
Locomotive Shop—P. & R.



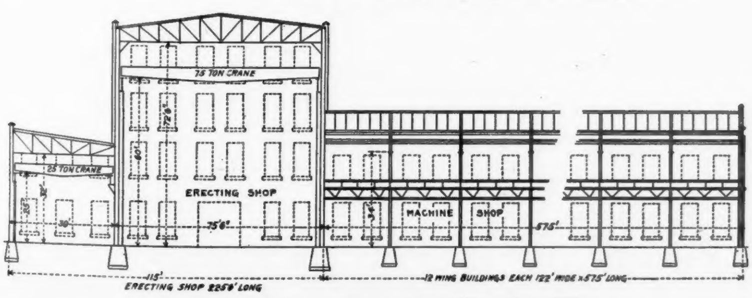
Locomotive Shop—L. S. & M. S.



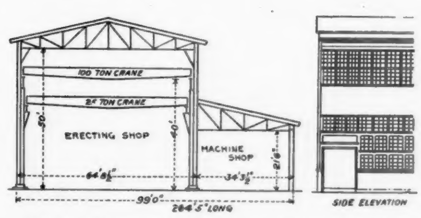
Allis-Chalmers Company—Milwaukee, Wis.



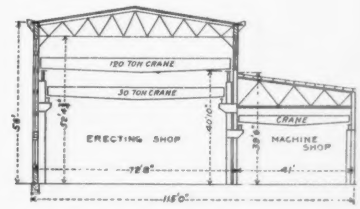
Locomotive Shop—P. & L. E.



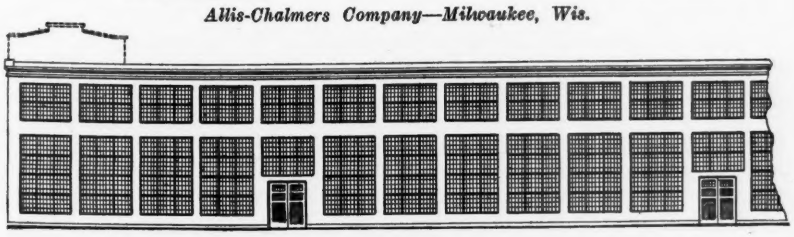
Allis-Chalmers Company—Milwaukee, Wis.



Rogers Locomotive Works—Paterson, N. J.

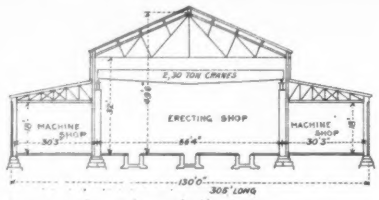


Richmond Locomotive Works—Richmond, Va.

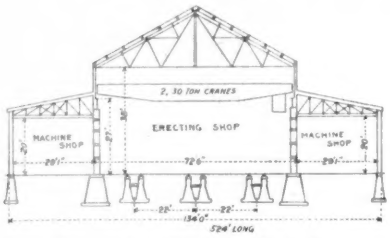

Locomotive Shop—L. S. & M. S.


Locomotive Shop—L. S. & M. S.

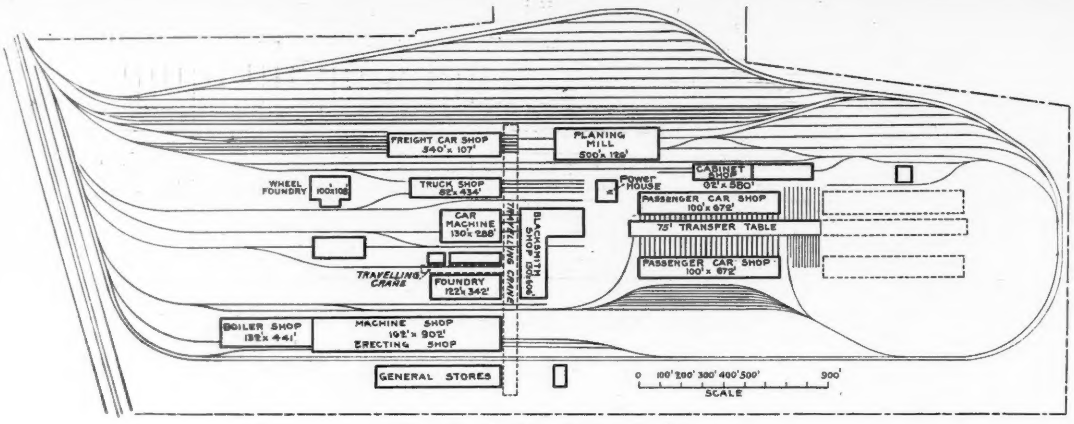
Plants Having Cross Erecting Shop with Heavy Traversing Crane.



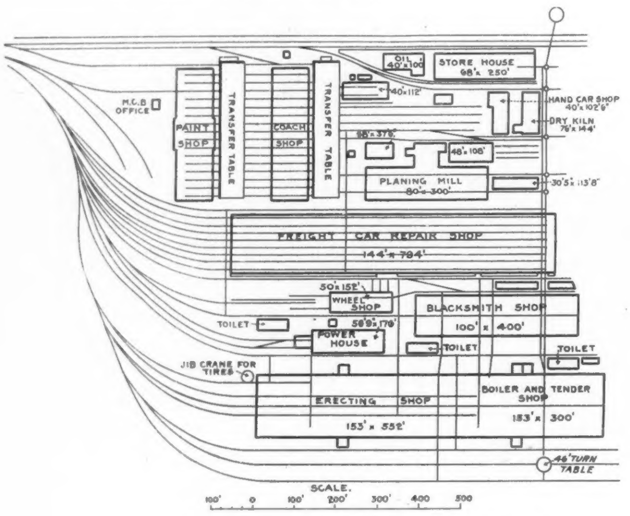
Locomotive Shop—B. & M.



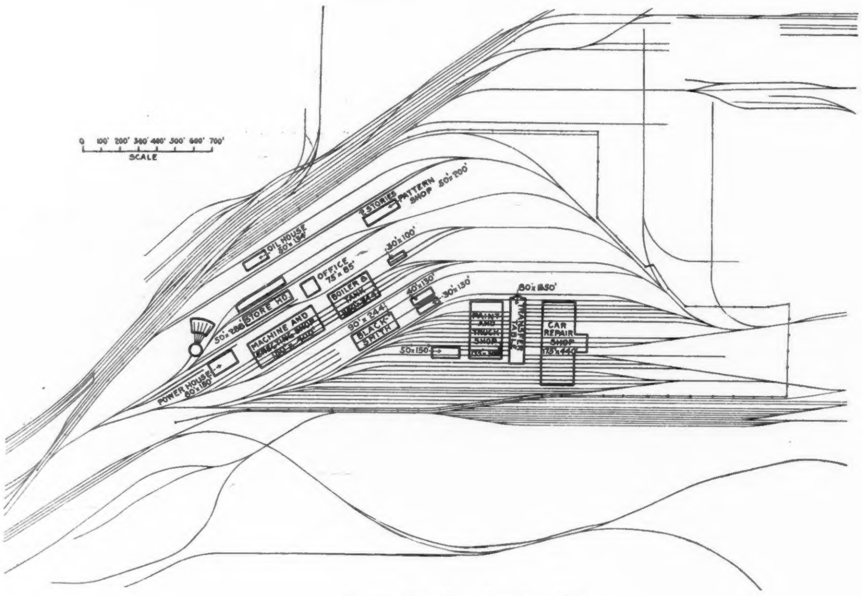
Locomotive Shop—B. R. & P.



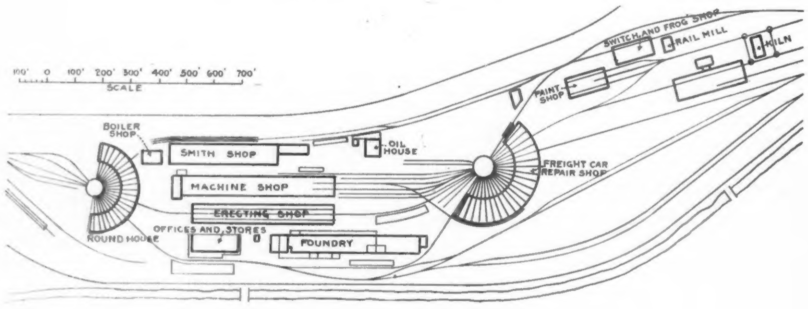
Canadian Pacific—Montreal, Can.



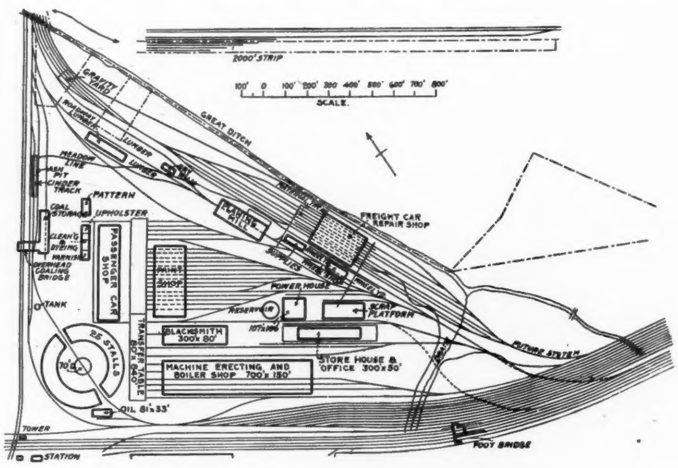
Atchison, Topeka & Santa Fe—Topeka, Kan.



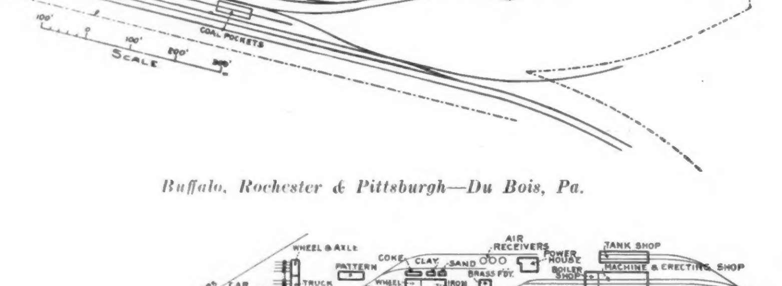
Union Pacific—Omaha, Neb.



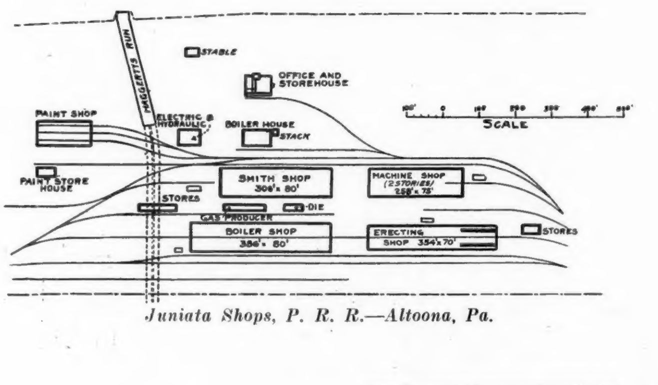
Norfolk & Western—Roanoke, Va.



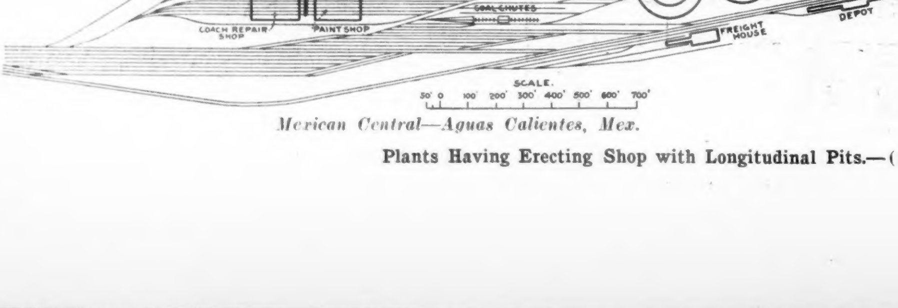
Central of New Jersey—Elizabethport, N. J.



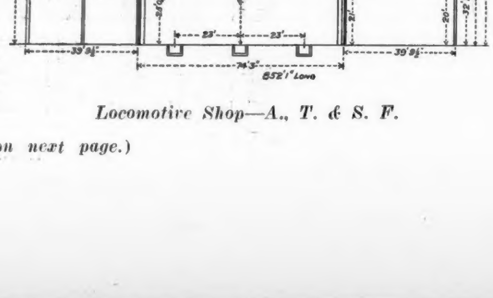
Buffalo, Rochester & Pittsburgh—Du Bois, Pa.



Juniata Shops, P. R. R.—Altoona, Pa.

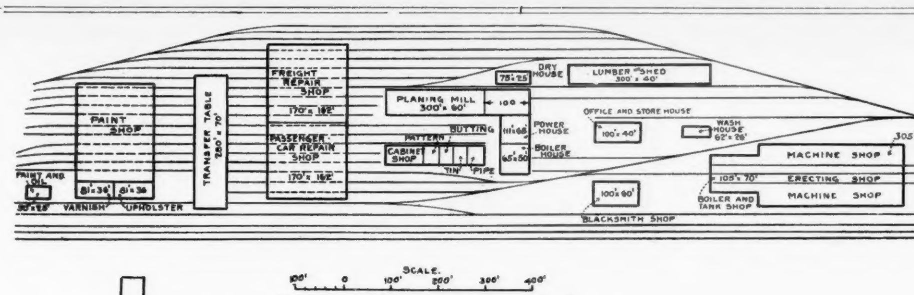


Mexican Central—Aguas Calientes, Mex.

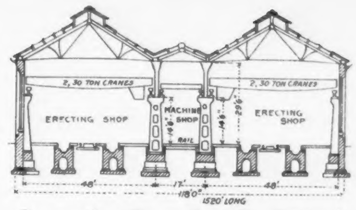


Locomotive Shop—A., T. & S. F.

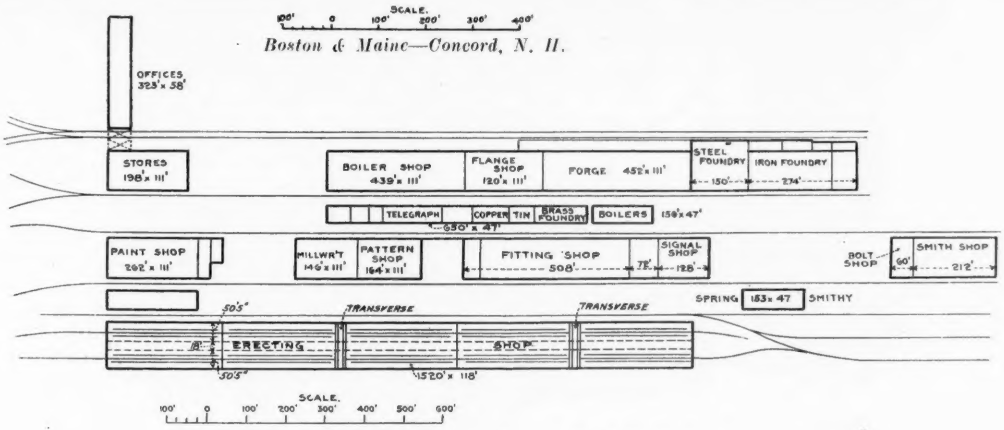
Plants Having Erecting Shop with Longitudinal Pits.—*(Continued on next page.)*



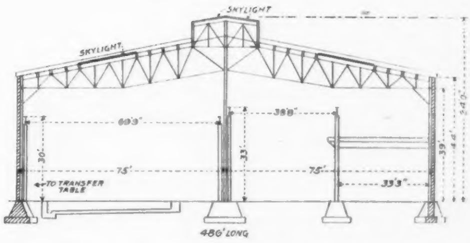
Boston & Maine—Concord, N. H.



Locomotive Shop—L. & Y., England.



Lancashire & Yorkshire—Horwich, England.



Locomotive Shop—Union Pacific.

Plants Having Erecting Shop with Longitudinal Pits *(Concluded).*

fitted for this heavy work. This is a feature that the advocates of heavy equipment did not foresee or take fully into account, the question having been treated largely from the transportation standpoint. The general balance sheet and annual expense records of old shops, compared with the possible savings under modern methods and up-to-date tools and appliances, will tell the story and point the direction for additional economy.

Particular attention should be called to the feature that it is not only the saving in expense that should be aimed for, but one of the greatest benefits of an up-to-date shop plant is the increased speed with which equipment can be turned out and restored to service. This feature of a modern shop plant is generally overlooked or underrated.

The following conclusions of the Committee of the American Railway Master Mechanics Association in 1894 on the subject, "Cost of Maintaining Locomotives," are very pertinent:

"The importance of centralizing the work of heavy repairs in one or more large shops on the system, well equipped for doing such work economically, should not be lost sight of. Heavy repairs conducted in small and imperfectly equipped shops not only cost more than at the main shops, but require more time and keep the engine out of service for a longer period than is necessary.

"In conducting repair work two important considerations should always be kept in mind—the actual cost of the repairs, and the time the engine is kept out of service in making them."

Classification of General Railroad Repair Shop Layouts.—Large general repair shops or main repair shops combining the work of repairing locomotives and cars can be classified, according to the leading characteristics of the ground plan layout and the grouping of the principal departments, as follows:

A.—Complete transfer table layout.

(a.) All departments combined along one transfer table.

(b.) All departments grouped along separate transfer tables.

B.—Combination of transfer table and longitudinal layout.

(a.) Longitudinal freight car shop; all other departments transfer tables.

(b.) Longitudinal locomotive erecting shop; all other departments separate transfer tables.

(c.) Longitudinal locomotive erecting shop, longitudinal freight car shop and transfer table passenger car shop.

C.—Combination of transfer table and cross locomotive erecting shop with traversing crane for lifting engines over each other.

(a.) Cross locomotive erecting shop with crane for lifting engines over each other, otherwise transfer tables for all other departments.

(b.) Cross locomotive erecting shop with crane for lifting engines over each other, passenger car shop with transfer table, and longitudinal freight car shop.

D.—Layouts without transfer tables.

(a.) All longitudinal layout.

(b.) Cross locomotive erecting shop with crane for lifting engines over each other, otherwise longitudinal layout.

Classification of Locomotive Repair Shops.—Locomotive repair shops can be classified, according to the ground plan layout and method of transferring locomotives into and out of the building, as follows:

A.—Cross track layout.

(a.) With yard approach.

(b.) With one transfer table.

(c.) With two transfer tables, one for the erecting shop and one for the boiler shop.

(d.) Cross erecting shop with traversing crane for lifting engines over each other.

B.—Longitudinal track layout.

(a.) All longitudinal layout.

(b.) Longitudinal layout in combination with a transfer table service at one end.

Cross erecting locomotive shops with cranes for lifting engines over each other set with the pits in the house at right angles to the general direction of the yard tracks have to be provided with a turn-table for handling locomotives in and out of the house.

Classification of Passenger Car Repair Shops.—There is no information at hand that any railroad company in this country maintains a separate large passenger car repair plant. The shops for taking care of passenger car equipment are generally connected with special car shops for passenger and freight equipment or form part of a general repair shop plant.

Omitting small older special designs, influenced by local conditions, passenger car repair shops can be classified as follows:

A.—Cross track layout with transfer table.

B.—Longitudinal track layout.

Classification of Freight Car Repair Shops.—There are a number of separate railroad plants for freight car repairs in this country, but frequently the repairs to passenger and freight equipment are combined in a separate large plant or form part of a general repair shop plant. Omitting special small designs, influenced by local conditions, freight car repair shops can be classified as follows:

A.—Cross tracks served by transfer table.

B.—Cross tracks with yard approach.

C.—Longitudinal track layout with yard approach at one end of main building and transfer table at other end.

D.—Longitudinal layout with track approach.

(a.) With track approach at one end of main building.

(b.) With track approach at both ends of main building.

Most of the plants with transfer tables have stub tracks or a track approach on the other side of the car shop, or a system of long parallel tracks at some part of the yard, for light freight car repairs. In longitudinal layouts most of the plants use the tracks on the approaches to the main freight car building for repair work in the open and further usually provide a series of long tracks, parallel with the main shop buildings and its approaches, for light repairs.

General Tendency of Railroad Repair Shop Layouts.—Reviewing critically the classification of railroad repair shop systems, and eliminating small plants more in the nature of division shops, and also giving consideration to the local conditions influencing the choice of certain designs, it can be stated as a broad proposition, based upon the best modern practice, wherever the conditions offer the designer practically a free scope, that the following designs are preferred, viz.:

Freight car. Heavy repairs.—Longitudinal main shop with track approaches at each end and in some cases with auxiliary transfer table at one end of the shop.

Freight car. Light repairs.—A series of long parallel tracks connected up with the yard at each end and preferably alongside of car repair shop.

Passenger car repairs.—Transfer table service.

Locomotive erecting shop.—Cross tracks and heavy traversing crane for lifting locomotives over each other; also longitudinal track layout.

For a small division repair shop of a large road or a general repair shop of a small road, with a maximum stall capacity of about 15 locomotives, the so-called "Division Shop" system of serving all departments by one transfer table is preferred.

(To be Continued.)

Foreign Railroad Notes.

The Tokyo Street Railroad is progressing. A big consignment of rails is expected on the 15th of March, and a large number of cars, wagons and other accessories are expected on April 15. The company has had much difficulty with the bridge and the poles for bearing the electric overhead wires, but these difficulties have for the most part been overcome and the work of laying the rails will be commenced in a few days. It is hoped the railroad will be opened to traffic by the middle of July.

The Post Office Department of the German Empire gives notice that until further notice no mail for Chinese ports, such as Port Arthur, Tientsin and Pekin, will be forwarded over the Siberian Railroad. Letters, etc., for these places, even though marked "*via* Russia" or "*via* Siberia," will not be delivered to the Russian post offices, but returned to the sender when he is known, otherwise forwarded to destination by way of the Suez Canal.

Steel-Concrete Construction.

BY A. L. JOHNSON, MEM. AM. SOC. C. E.

So much is being written nowadays about steel-concrete construction, and so many apparently different theories of design are being offered by the specialists that the practicing engineer, having little time for winnowing, often prefers to stick to old standards rather than run the risk of getting chaff, especially as the doctors themselves do not agree.

But the disagreement is more apparent than real. Some of the theories are good, some bad. But after all there are so many tests available, to some of which at least, in all cases, the theories have been made to conform by the insertion of proper empirical coefficients, that it may be said that all theories have more or less common ground. It is not to be denied that there is a good deal of chaff, but at the same time there are certain main facts which cannot be gotten away from, and in locating a road it is well once in a while to climb a tree and take a look around.

An examination of the topography of the field of steel-concrete construction will reveal certain prominent features, some of which are stated below:

1. It is a masonry construction having at least as much strength in tension as in compression.

2. It will not crack, hence is not injured by frost; is not disintegrated by the carbonic acid of the air, but is, in fact, hardened thereby, and hence is everlasting.

3. It is cheap and easily moulded to suit any case with ordinary, and available, labor.

4. It can be nearly everywhere obtained of fairly uniform quality, getting the bulk material at, or near, the site.

5. Careful workmanship is of much less importance than with any other kind of engineering structure; a proper design and wet concrete will insure good results.

Now let us consider what the results would have been if for the last two thousand years we had had a material with as much strength in tension as in compression. Would our designs be what they are to-day? Manifestly not. Instead of small arches we would have beams, except where artistic effect was desired. Our large arches would probably be twice their present length. Many structures would look like the present ones reversed or turned upside down. For example, retaining walls would be thin, shaped like an L with the toe turned into the bank; sewers and culverts would usually have an arched bottom with a flat top. Masonry plate girder bridges of 100-ft. span might now be in use. No doubt a successful permanent roadbed would have been developed years ago. The present tinder box style of residence construction would probably never have originated. Masonry dams would be much like those we now have, but many disastrous fail-

ures would no doubt have been averted. These things we can readily imagine, but as to what marvels of construction the ancients would have wrought with such a material we can only wonder. And now comes the twentieth century bringing with it just such a material. Necessarily its advent marks a new era in structural art. Standing apart and taking a broad, common-sense view of the situation, it takes no prophet to foresee that a complete revolution in our methods of construction is inevitable. When this condition is realized by the engineers at large they will very soon familiarize themselves with the few details necessary to enable them to separate grain from chaff and obtain such a material as above described.

Two things there are that are essential: First, a perfect and permanent bond must be provided between the concrete and the metal. Second, the metal must be distributed in small areas throughout the distorting concrete. The whole science and art of steel-concrete construction depend upon these conditions being met.

Those who have done much in this line of construction are satisfied that plain bars cannot be relied upon to meet the first condition, and as a result, various styles of reinforcing material have been devised to overcome the difficulty. Without drawing any invidious comparisons between these materials, but simply assuming that the adhesion does not exist, we see at once that theoretically, the reinforcing material should be provided with surfaces nearly at right angles to the direction of stress, varying therefrom by an amount not exceeding the angle of friction between concrete and metal. This is not theory alone, but common sense as well. To meet the second condition is very simple; in fact, it is cheaper and easier to lay the material in small areas close together than in heavy sections at widely distributed points. As a general proposition the metal areas should not be more than 12 in. apart.

While the present article is only intended to give a general view of the situation, it may perhaps not be amiss to give the beam formulæ for rectangular sections for average concrete to show the ease with which such beams may be designed. By average concrete is meant ordinary limestone macadam concrete, mixed in the proportion of 1, 3 and 6. For such concrete the modulus of elasticity will be about 3,000,000, and the crushing strength 2,000 lbs. per sq. in. Using corrugated bars, the elastic limit of which lies between 50,000 and 60,000 lbs. per sq. in., the formulæ become:

$$y_2 = 1.72\ y_1 \qquad (1)$$

$$\frac{a^2\ b}{d} = .0195\ b\ y_1 \qquad (2)$$

$$M_0 = 2750\ b\ y_1^2 \qquad (3)$$

$$h = y_1 + y_2 + e \qquad (4)$$

In these equations, y_1 is the distance from the neutral axis to the compression side of the beam; y_2, the distance from the axis to the center of metal reinforcement; M_0, the moment of resistance in inch-pounds at rupture; e, the distance from the center of metal reinforcement to the tension side; h the depth, and b the width of beam; and $\frac{a^2 b}{d}$ is the number of square inches of metal in the beam. The value e is usually taken at about two and one-half times the diameter of bar used in the reinforcement.

Suppose, for example, it is required to determine the section of a steel-concrete beam, capable of carrying a safe load of 1,000 lbs. per square ft. on a 10-ft. span, with a factor of safety of four. The bending moment for proof load is then for a section 1 ft. wide.

$$M = \frac{12 \times 1{,}000 \times 4 \times 100}{8} = 600{,}000 \text{ in. lbs.}$$

Equating M_0 with this value, and remembering that b is 12, we have

$$M_0 = 33{,}000\ y_1^2 = 600{,}000.$$

From this we obtain,

$$\begin{aligned} y_1 &= \ 4.27 \text{ in.} \\ y_2 &= 1.72y_1 = 7.34 \text{ in.} \\ e &= \text{say}\ \ 2.50 \text{ in.} \\ \hline h &= 14.11 \text{ in.} \end{aligned}$$

From (2), $\frac{a^2 b}{d} = .234 \times 4.27 =$ sq. in. This would require ⅞ in. square corrugated bars, having a net section of 0.5 sq. in., six inches apart.

Continuous Concrete Walls Without Expansion Joints.—Another matter that perhaps may be properly spoken of here, it not having been discussed in any literature so far published, relates to the practicability of building continuous concrete walls without expansion joints and without any danger of cracks.

The writer's company has built continuous walls 300 ft. in length, 8 in. thick, and exposed on both sides to the weather, which are now about one year old and in perfect condition. He is satisfied that a wall a mile long could just as readily and successfully be constructed.

But it usually takes more than an optical demonstration to convince an engineer. He will not believe it when he sees it, unless he can understand why it is so. For this reason the following theoretical explanation is appended:

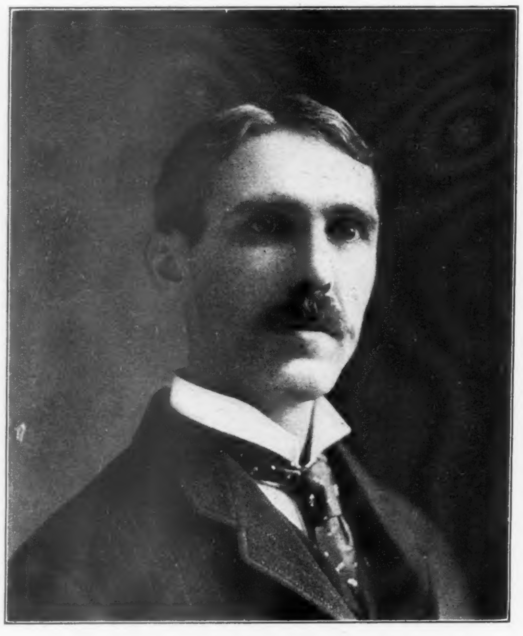
Continuous walls will crack vertically in lengths such that the weight of the section multiplied by the coefficient of friction on the soil is equal to the tensile strength of the wall. The temperature required to crack the wall in these lengths is that temperature requiring a shrinkage in excess of the ability of the wall to stretch. Now, plain concrete can stretch very little before cracking. But concrete thoroughly reinforced with metal can take a proportionate elongation of .0018 before cracks will be developed.

The maximum shrinkage that would be required could not be due to a fall in temperature of more than 125 deg. The coefficient of expansion of concrete is .0000055, which for 125 deg. becomes .0007 per unit of length, or less than one-half the ability of the re-enforced concrete to stretch. No crack, therefore, could be produced with a fall in temperature of less than 250 deg., which, of course, would be impossible to realize in practice.

The quantity of metal used should be enough to equal the tensile strength of the concrete at the elastic limit of the metal. Calling the tensile strength of stone concrete 200 lbs. per sq. in., and the elastic limit of the steel 55,000 lbs. per sq. in., the number of square inches of steel required would be $\frac{1}{275}$ of the number of square inches in the wall section.

Hunter McDonald.

Mr. Hunter McDonald, nominated as incoming President of the American Railway Engineering & Maintenance of Way Association, was born at Winchester, Va., June 12, 1860, and was the eleventh member to join the Association. Mr. McDonald lived, as a child, at Lexington, Va., and in 1873 went to Louisville, Ky., and was graduated from the Louisville Rugby School in 1878. He attended the engineering department of Washington and Lee University in 1878-79, and in August, 1879, entered the service of the Louisville & Nashville in charge of a small party, measuring the road, re-establishing mile posts, and recording locations. After completing this work, in 1879, Mr. McDonald entered the service of the Nashville, Chattanooga & St. Louis, as maintenance of way clerk and Assistant Engineer. Since that time he has been continuously in the service of that company. In 1882 Mr. McDonald was elected a junior in the American Society of Civil Engineers; became a full member in 1887, and



in 1889 assisted in organizing the Engineering Association of the South.

From 1879 to 1890 he fulfilled various duties relating to maintenance of old lines and location and construction of new ones, and in 1889 and 1890, was Division Superintendent of the Huntsville Division. In 1891 he was Resident Engineer of the Western & Atlantic at Atlanta, in charge of the general rebuilding of the track and bridges. In November, 1892, Mr. McDonald was appointed Chief Engineer of the Nashville, Chattanooga & St. Louis, and still occupies that position. In addition to his railroad connections, he is a member of the National Geographic Society.

Railroad Location.*

Reconnaissance.—Classifying by the successive processes of survey and construction, the first item, reconnaissance, is conspicuous on most roads by its absence. A well defined systematic examination and determination, in advance of instrumental survey, of controlling points appears to be undertaken by few roads over any large area. Apart from the general indications furnished by maps, and the suppositions of farmers, woodmen or Indians, but little preliminary information appears to be gathered, and no general determination made of numerous controlling altitudes and positions, before "running the preliminary." In consequence, the running of preliminary lines in actual surveys has been needlessly long and expensive. On one road less than 100 miles in length, and in a valley where the general course was defined, over 600 preliminary lines are known to have been run. A liberal determination of positions and double barometer work, or what might be termed detail reconnaissance, however inaccurate for minor variations of altitude, would have eliminated nine-tenths of these instrumental preliminaries. The lack of such detail reconnaissance over broad areas is seen in the huge detours, northward and southward, of the Northern Pacific; in the present scenic line of the Canadian Pacific west of the summit of the Rockies, and its much admired loop west of the Selkirk summit; in the famous Tehachapi loop of the Southern Pacific, where a desperate struggle is made, by turning a complete circle, to gain a very little distance, which a properly established summit cut and slightly different gradient rate would have avoided.

The Alleghenies, with their long, even ranges and nearly level crest lines, presented a fine field for careful detail reconnaissance, there being no deep passes in the crest line so definitely marked as to exclude reconnaissance work along the range. Even many years after construction, the Pennsylvania was still examining instrumentally other possible crossings of the range and other summits, such as Three Spring Gap, Emigh's Gap, etc.

Location.—The method of location of most of our railroads can more properly be termed a lack of any method. Each locating engineer has been allowed to take his own course, with no standard for different types of country. On some important roads one long preliminary line has been run through a valley already defining the route. Then the final location has been forced into place, sometimes aided a little by this preliminary, but generally far from it and unaided by it. A series of acrobatic performances in backing off and butting at the ground repeatedly with one curve after another, has been the substitute for systematic locating. If a preliminary has been run, the locating from it has been "from hand to mouth" work, in short sections. The locating engineer would go forth, return and remember "about where he wanted to be" with reference to the preliminary, and calculate his final location from his daily memory.

A thorough system of topography and proper location, although generally heretofore used only in rugged country, is really needed even more in light, rolling country, such as that crossed by many of our so-called "prairie lines." In such country a line can be run anywhere, with usable gradients. The best line can only be determined by a broad but close examination of long stretches or areas of country. In no way can this be done except by placing the country, approximately accurately, on paper, and studying the longer possibilities. The Canadian Pacific between Winnipeg and Calgary shows evidence of lack of such topographical treatment.

In the details of such topographical work, there appears to be much variety of method and selection of instruments on American railroads. The slope instruments, giving angle of surface slopes, with lengths of same measured generally on slope, has been proved to be the most rapid. On the Pennsylvania branches such slopes were taken to a distance out regulated by the proposed gradient rate, the character of the country and the closeness of the preliminary line to the probable location. From 300 to 600 ft. horizontal, or from 25 to 50 ft. vertical, were the usual ranges. Beyond this the slopes and distances were taken by eye, and noted on the map in some way distinguishing the eye work from the measured work. The topographer's eye becoming trained, much of the eye work became very accurate, and at times, with trained topographers, was substituted for measured work. The actual profile in most cases coincided very closely with the predicted paper profile, based upon such eye work topography. In such eye work it is requisite that the preliminary be fairly near the probable location, and that the slopes of ground be not too light. Slight changes, purely local, have no importance in deciding the location.

The Allegheny region is an excellent country for the practice of such paper locating. It is not only rugged, but timbered. The butting locator cannot see far enough to butt, and would have to convert his party into a lumbering camp, in clearing for his successive attempts. The "memory" locator is at a heavy disadvantage. A transfer of the country to paper is almost a prerequisite for locating. On one of the slopes to the main summit of the Pennsylvania, after many attempts at field locating, the whole country was thrown upon paper and the location decided in Philadelphia.

Entry of the topography upon the map in figures only has been found much better than to elaborate the contours before planning the location. If the figures are made small and distinct and entered in ink, many possible locations can be made in pencil and successively rubbed off after rejection. The elevations being taken at each important change of ground in each cross section, and the sections being taken to suit and develop the ground, the numerous small figures on the map make the best possible representation of the ground.

The locating engineer gets in his best work between 9 p. m. and 2 a. m., undisturbed by his fellow engineers. The preliminary of the day has been platted by the transitman. The leveler has entered on the plat the elevations of center line. The topographer has entered the lateral elevations and notes. Then the map is ready for the locating engineer and his night study. He can determine his location so that when the preliminary line is resumed each morning it can be intelligently pushed ahead, since its relation to proposed location has been determined each evening. Such close methods of study of the location will enable a locating engineer to revise the locations of others, throwing out needless curvature or expense. The writer ventures to mention one of his experiences in such revision on the Canadian Pacific. At the Albert cañon of the Ille-cille-waet River, on the west slope of the Selkirk Range, the location fixed by the prior locating party was low down in the bottom of the rocky

*Extract from a paper presented to the Western Society of Engineers, Dec. 17, 1902, by Mr. Archibald A. Schenck.

cañon, with proposed heavy rock work and tunneling. The situation was a tight one. A very narrow belt or shelf existed about a hundred feet higher up, but the general country was much obscured by dense timber, and any other line was pronounced impossible by the powers that were. A series of preliminaries were run out like threads through the dense woods. The topography was secured from these, and the ground, so to speak, was picked up and put on paper. A line was found saving $237,000, which is the present operated line, and contains nothing remarkable to the eye. The revision was made on snow shoes over 8 ft. of snow, levels being taken on top of line rods forced down to the ground, and settings of the instruments being made on huge fallen timber.

On branches of the Pennsylvania nearly all the preliminary alignment was taken with the compass, with ball and socket joint; very little was taken with the transit. The balancing of small errors nearly always gave a result closer than any possible platting of the alignment or the location, even with the finest lines penciled in the platting, on scales of 400 ft. or 200 ft. per inch. The practical results when the location was run in with transit were found as good as if the preliminary alignment had been run in with transit. The saving of time in setting up, lightness in the compass when carried in rough timber, and the saving by setting only at alternate turning points where grade line was ahead, nearly doubled the rate of advance. In one respect the work was safer than transit work unchecked by compass, as no error would be carried beyond its own course, as with transit work, and affect increasingly all subsequent work.

Accuracy Required.—Accuracy, with the various degrees of the same demanded on various roads, has been an interesting study. The Southern Pacific represented one extreme in this quality. Nearly all the work, even of preliminaries, was done with steel tape and two plumb lines. Fifteen hundred miles southward and eastward from Central California, far into the desert, the steel tape and plumb bobs were continuously at work. Where one preliminary crossed another, or the location crossed the preliminary, the proposed crossing, station number and plus, and angle, were calculated in advance, and must conform within an inch or two, and to a minute or thereabouts of angle. All latitudes and departures were calculated for every course both of preliminary and location, the latter including spirals, and recorded in a series of books.

Estimates.—On the Southern Pacific an unusual method of dealing with quantities of work exists. The engineer parties do no cross-sectioning or measuring for quantities during construction. No quantities are calculated, nor record kept of the same. There are no estimates to be made, monthly or final, no contractors to be paid. On the basis of a preliminary estimate made up by the Chief Engineer, the entire work is contracted by the railroad company to the Pacific Improvement Company for a lump sum. Whether the lump be too large or too small in proportion to the work, or what profit the Improvement Company may make, not even the engineers can tell. The method employed leaves large power and responsibility centered in the Chief Engineer, unchecked by any work of subordinates or others.

Camp Subsistence.—This item of subsistence of engineering parties is a homely topic, giving no special opportunity for scientific discussion or for fame. It is simply a useful topic which has been very generally ignored as beneath the notice of scientific bodies. A great general, even a Napoleon, may very closely consider all details of commissary, but many eminent engineers have felt their calling to be above such details. But the demand is greater upon the engineer than upon the army leader to look after supplies carefully. The subordinates of the engineer can leave at will, or to some extent neglect their work if they be made discontented. New recruits are not always obtainable in the wilderness. The enormous sums paid out yearly by our railroads are to secure just one thing, willingness; willingness to work and to remain at work. Nothing, except an overbearing or overthreatening superior, can more quickly neutralize the company's cash expenditures for wages and convert willingness into the reverse, than poor equipment and supplies when the company agrees to furnish them. Their cost (as also that of expense accounts on settled lines of roads) does not aggregate much compared with the total of a pay-roll, but every dollar spent for reasonable subsistence or expenses counts double generally any dollar on the pay-roll. On the Northern Pacific, the O. R. & N. Co., the Oregon Pacific, the Canadian Pacific, and the Southern Pacific roads, there was a uniform liberality in the furnishing of supplies to the engineer camps. All the cost of camp subsistence, both on construction and location, was paid by the railroad company. Equipments were ample and of good quality. Camp cooks were paid from $35 to $50 per month and board. Provisions included not merely necessaries, but such things as canned fruits and vegetables; also fresh meats and vegetables when purchasable. On the Canadian Pacific blankets (and buffalo robes formerly) were furnished by the company. The utmost care was taken to provide every article of cooking and camp utensil to insure smooth progress of domestic arrangements, and turn the attention of the engineers away from anxious care for bed and board and towards their proper engineering work. On some roads a special commissary agent was employed for large camps, relieving the engineer of all camp work during movement of camp. On the day of moving the engineering work went on as usual. The party reported in the evening at the new camp, finding the evening meal ready, bedding (of boughs or otherwise) arranged, and the luggage of each man in his tent. On the other hand, many eastern roads when attempting camp subsistence make a wretched failure of it. A large part of the essential outfit is omitted or improperly selected, causing trouble after parties have gone beyond ready reach of articles. Deficient food, poorly cooked and served in slovenly fashion, poor and insufficient tents, bedding, stoves and appliances, cause discontent, poor quality of engineering work, slow progress and frequent desertions.

In very wild countries, such as the Canadian Pacific region, mail facilities were provided by the company. Two visits per week were made by the mail carrier on horseback, even to the most remote camps. Hospitals were established in log cabins each 50 to 75 miles, with a staff of head physician and a local physician at each hospital. The local physicians rode over their territory three or four times per month, and more often when called. A fee of 75 cents per month was collected from each man, medicines being furnished without further charge. The Southern Pacific collects 50 cents per month from all employees and has built several excellent hospital buildings. . . .

Numerous other points of diversity in practice have been noted in alignment and referencing, reporting, accounting and distribution, organization, and the tender topics of spirals, bridging and concrete. The limit of the paper will not permit mention of the marked difference of practice in these items of work.

George W. Kittredge.

Mr. George Watson Kittredge, the retiring President of the American Railway Engineering & Maintenance of Way Association, is now Chief Engineer of the Cleveland, Cincinnati, Chicago & St. Louis. He was born at North

Andover, Mass., Dec. 11, 1856, and graduated from the Massachusetts Institute of Technology in 1877. In 1878 and 1879, Mr. Kittredge was connected with the New York & New England; in 1879 and 1880 he devoted his attention to general practice, but during the latter year joined the engineering corps of the Pittsburg Division of the Pennsylvania. From 1883 to 1886 he was Engineer of Maintenance of Way on the Muskingum Valley Division; from 1886 to 1888, of the Louisville Division, and from 1888 to 1890, of the Pittsburg Division.

Mr. Kittredge became Assistant Chief Engineer and Engineer of Maintenance of Way of the Cleveland, Cincinnati, Chicago & St. Louis in 1890, and has been Chief Engineer since 1891.

Tests of the Relation Between Cross Bending and Direct Compressive Strength in Timber.

BY PROF. CLARENCE A. MARTIN.*

The practical value of these tests is: If we wish to know what load a wooden beam will carry without injury to its elastic properties, we need only to test the material in direct compression endwise and take the ultimate compressive strength as the fiber stress at the elastic limit under cross bending. We may then for any given size of beam very easily compute the load that will produce this fiber stress in any beam, or compute the load that will give any definite proportion of this fiber stress according to the factor of safety that we may deem advisable in any given case. To test directly for flexure on a satisfactory scale has been a most difficult and cumbersome matter, but the test for direct compression is the simplest, most direct, and most easily performed of any of the tests that may be applied.

The tests that furnish the basis for this discussion were undertaken in the laboratories of Cornell University, by Prof. Clarence A. Martin and Mr. George Young Jr., for the purpose of comparing the unit stresses in timber under flexure at the elastic limit with the ultimate strength of the timber under direct compression endwise, and for the purpose of obtaining experimental evidence relative to the principle set forth by Mr. S. T. Neely in an article printed first in Circular 17 of the Division of Forestry—U. S. Department of Agriculture—in 1897, and again on page 372 of Dr. B. E. Fernow's report to Congress—H. Doc. No. 181, 55th Congress, 3rd Session—and also in Circular No. 18 of the Timber Physics Series, U. S. Division of Forestry.

This principle is, in brief, that in a wooden beam subjected to flexure the unit fibre stress at the true elastic limit is equal to the ultimate strength of the material in direct compression endwise. This important principle Mr. Neely derived from observation in compiling the results of several thousand tests made in the extensive timber physics investigations instituted by Dr. Fernow. Mr. Neely treats the subject mathematically and deduces some interesting formulæ dealing with the beam both at the elastic limit and at rupture, and he says: "Unfortunately no tests have been made to study the application of these formulæ." The tests from which the principle was derived had been made for another purpose entirely and the data available were not sufficiently complete to give satisfactory answer to this inquiry. This it was that suggested this series of tests which were made in connection with the course in Timber Physics under Prof. Filibert Roth, of the New York State College of Forestry at Cornell University. Inasmuch as the elastic limit is the critical point for all practical purposes, these investigations have been confined to that point.

The test pieces were 40 in number. They were approximately 1¾ in. square, 46 in. long, well selected, thoroughly seasoned, and in the main straight grained and free from knots. Each stick was marked with a Roman numeral and its depth and width noted to the nearest .01 of an inch. Pieces Nos. I to XX, inclusive, were of white pine, XXI to XXX were of tulip (yellow poplar), XXXI to XXXIII were of maple, XXXIV and XXXV were of oak, and XXXVI to XL were of chestnut.

The bending tests were made in a machine of the regular type fitted with a wheel divided into 333 parts working a screw of three threads to the inch, thus rendering it possible to read easily a deflection of .001 of an inch. The test pieces were supported on iron rollers fixed at 36 in. apart. The load was applied at the middle of the beam through a small steel plate which was about ¼ in. thick, 1¾ in. wide, about 3 in. long, and slightly convex on the side bearing on the beam. The stick and the bearing plate were placed on the machine and the scales balanced. The screw was then turned down until the balance indicated a contact or a barely perceptible pressure. The sliding weight on the scale beam was then set at 50 lbs. and the screw turned down until the scale beam again balanced, thus indicating a load of 50 lbs. on the beam. At this point the deflection was noted from the divisions on the wheel attached to the screw. The loads were then increased and the scales set to balance at each 50 lbs. additional weight, the corresponding additional deflection being noted for each 50 lbs. increase in weight until the beam failed.

Care was taken throughout to apply the loads gradually, and in order to avoid ambiguity in the curve beyond the elastic limit the deflections noted were those corresponding to the first balance of the scale beam, even though the beam sank again before the application of the next load.

For the compression tests two blocks each 2 in. long were cut from each test piece, one block from each end of the piece. These pieces were cut from the portions of the stick that projected over and beyond the roller bearings in the flexure test, and the work was done by a machine saw to insure square bearing ends. The dimensions of each piece were noted to the nearest .01 in. and each piece was marked for identification. These blocks were tested to failure under endwise compression, the first 40 in an Olsen machine with successive loads of 250 lbs., and the next 40 in a Riehlé machine, the ultimate load in each case being noted to the nearest 50 lbs.

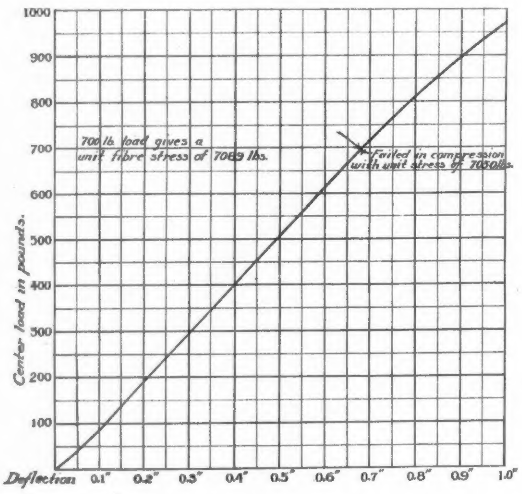
The general results of the tests are indicated in the accompanying tables. It would be clearly impracticable to give within the limits of a magazine discussion complete tables and diagrams showing the results in detail of these tests, but the condensed table and one typical curve of flexure will serve to show with a fair degree of accuracy the general results obtained.

The results of the tests were surprisingly uniform and in the selection of the test pieces to be represented in the table here given no special discrimination has been exercised further than to have the different woods represented. The first vertical column of the table gives the load on the beam in pounds. The other vertical columns show the added deflection in decimals of an inch for each added load, and the Roman numerals at the top of the columns are the numbers used to identify the individual test pieces. In the horizontal column A, the figure under each vertical column of deflections is the ultimate endwise compressive strength per square inch of the material as determined by averaging the ultimate strength of the two blocks cut from the test piece. The figures in the horizontal column B are the loads that in flexure would produce a fiber stress in the beam equal to the figures in column A. It is interesting to note how closely these correspond with the weights that cause an increase in

*College of Architecture, Cornell University.

the rate of deflections as shown by columns above. This is indicated as nearly as posible within the limits of the table, by the heavy lines crossing the deflection columns.

The diagram accompanying the table shows the curve of flexure for test piece No. III, and is fairly typical of the 40 pieces tested. The loads were plotted as the vertical and the deflections as the horizontal co-ordinates. In this piece the endwise compression test showed an ultimate strength of 7,050 lbs. per sq. in., while the calculated fiber stress for a center load of 700 lbs. is 7,089 lbs. The arrow on the curve is then placed just slightly below the load line indicating 700 lbs., and would, if Mr. Neely's theories are correct, indicate the true elastic limit. As a matter of fact, if a straight-edge be placed on this curve it will be found that the curve is practically a straight line up to this point, and that just at this point it commences to drop very perceptibly, indicating experimentally that this is the true elastic limit.



Deflections Under Progressive Loading at Center of a White Pine Stick, 1¾ in. Square, on Supports 36 in. Apart.

TABLE SHOWING PROGRESSIVE LOADING AND THE ADDITIONAL DEFLECTION DUE TO EACH ADDITIONAL LOAD.

Loads in lbs.	Deflections in decimals of an inch. III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XXIV.	XXXIV.	XXXVIII.	XXXIX.
50	.061	.055	.065	.067	.069	.065	.076	.067	.052	.059	.080	.053
100	.057	.042	.051	.058	.054	.054	.059	.059	.040	.044	.058	.048
150	.046	.040	.046	.056	.052	.052	.056	.052	.036	.043	.061	.043
200	.045	.040	.046	.056	.048	.052	.056	.050	.036	.037	.057	.043
250	.049	.039	.047	.053	.051	.051	.054	.053	.035	.040	.058	.041
300	.048	.041	.047	.056	.050	.052	.056	.052	.037	.040	.059	.043
350	.046.	.039	.047	.056	.051	.051	.056	.051	.037	.036	.056	.043
400	.048	.040	.048	.056	.051	.052	.056	.052	.036	.040	.058	.043
450	.047	.041	.047	.056	.049	.051	.058	.052	.037	.040	.059	.043
500	.047	.040	.047	.058	.051	.053	.057	.053	.037	.041	.059	.044
550	.048	.041	.047	.058	.052	.055	.060	.054	.037	.040	.063	.043
600	.047	.042	.048	.060	.054	.055	.061	.052	.038	.040	.062	.044
650	.050	.039	.050	.061	.053	.057	.062	.054	.037	.041	.065	.045
700	.050	.042	.048	.064	.055	.059	.066	.057	.037	.041	.069	.044
750	.050	.042	.050	.064	.059	.062	.069	.057	.039	.040	.072	.046
800	.054	.043	.053	.069	.057	.063	.078	.064	.038	.044	.070	.051
850	.053	.049	.055	...	.063	.066	.074	.067	.039	.045	.083	.050
900	.062	.066	.056	...	.069	.071	.080	.078	.039	.048	.081	.052
950	.062	.053	.075	...	.075	.082	.090	.099	.042	.051	.099	...
1000	.072	.059	.080	...	.085	.078	...	.122	.043	.054	.096	...
A......	7050	7288	6573	6487	6516	6269	6747	6584	9752	10077	7341	8409
B......	695	710	650	645	640	630	680	640	930	900	650	760

Explanation of Table.

The Roman numerals are the numbers used to designate the several test pieces, and the figures in vertical columns underneath them are the additional deflections in decimals of an inch produced by each additional load of 50 lbs. The figures in the horizontal column A show for each test piece the ultimate crushing strength per square inch in direct compression endwise. The approximate position of this loading is indicated in the vertical columns to the nearest 50 lbs. by the heavy lines crossing these columns of deflection figures.

This test was applied in the same manner to each one of the 40 pieces tested and in all but four cases the arrow, located from the compressive tests alone, indicated the true elastic limit in very close agreement with the curve.

In each of the four pieces that failed to bear out the rule, viz., Nos. XXV, XXX, XXXV, and XXXVI, the following significant facts may be noted. (1.) All were hardwood pieces. (2.) All failed before the elastic limit determined by the compressive tests were reached. (3.) The curves are all practically straight to the point of failure. (4.) Each piece failed at a point considerably lower than other pieces of the same kind of wood and of the same dimensions. With reference to the first point, the comparative uniformity of all data in connection with the tests of the pine sticks is worth noting; the greater irregularity of the data for the hard woods being undoubtedly due to the less regular structure. As to points 2, 3 and 4, in the four pieces referred to, these observations would seem to indicate sudden and unlooked for failure due probably to imperfections such as knots, season checks, or cross grain. Unfortunately the original pieces are not now available for study and their conditions were not carefully enough noted at the time of the tests to separate them from the others.

While there is always a certain amount of danger to the cause of truth and science in generalizing from insufficient data, there is, nevertheless, in this series of tests a strong practical confirmation of the truth of Mr. Neely's theory. Forty tests with ragged and inharmonious results would mean little, but the same number of tests with practical uniformity in results must of necessity beget some degree of confidence and become of sufficient importance to be taken seriously.

The Development of Buffalo Harbor.*

Up to 1869, when the outer or detached breakwater was begun, Buffalo harbor and Buffalo creek may be considered synonymous terms. Naturally there existed no safe place in this vicinity where vessels could lie, or could receive and discharge cargoes, except the area within the mouth of Buffalo creek. The mouth of this creek was generally closed to navigation, even to the small vessels of the time, by a gravel bar. Freshets would occasionally open the channel through this bar, which would soon be closed up again by the waves of the lake. The earliest work of improvement was done by private enterprise, assisted subsequently by the State of New York. In this way parallel jetties were built at the mouth of Buffalo creek, which concentrated the current and practically removed the bar. These jetties, now called the south pier and north pier, were built in 1820-21, and were at that time respectively 1,300 and 1,000 ft. long.

In 1826 the works passed to the control of the United States, and in that year the sum of $15,000 was appropriated by the same. In the years immediately following, the piers were rebuilt and extended by the Government, which has ever since retained charge. The north pier originally consisted of a row of piles, filled with brush and sand; subsequently it was rebuilt of timber cribs filled with stone. At the present time this pier is occupied by the coal loading dock of the Delaware, Lackawanna & Western.

The south pier, begun in 1819, was built of timber cribs, filled with stone; a protection mole of stone 15 ft. above lake level was started in 1828. What is known as the sea wall, an extension of the south pier southwards along the lake shore, was begun in 1834. The object of the sea wall was to protect the lake front of the city against the storms of Lake Erie. In 1867 this sea wall had reached a total completed length of 5,400 ft. No work was done on the sea wall after 1867, for the reason that the outer breakwater was begun in 1869, and this structure rendered the sea wall unnecessary and useless.

Between the years 1835 and 1844, various projects for outer breakwaters were presented. It was not until 1867, however, that the creation of an outer harbor took tangible shape. In that year a project was decided upon, which proposed the location of a breakwater on the line on which it is now built. This has reference to what is usually called the old breakwater. Beginning with the time, coincident with the building of the Erie Canal, up to the year 1867, the various schemes for the improvement of Buffalo harbor, as modified at various times, might be summarized as follows: the construction of a north and a south pier at the mouth of Buffalo creek, a masonry sea wall running south from the inshore end of the south pier, and a breakwater a little less than a half mile in front of the Buffalo lighthouse, its arm running nearly parallel with the shore in a direction nearly northwest and southeast.

Many of my hearers are also no doubt familiar with the old sand catch pier jutting out into the lake from the shore, a short distance above the foot of Michigan street. This pier was originally built for the purpose of collecting or catching the sand and preventing the shoaling of the water at the mouth of Buffalo creek. It was commenced in 1875. After the outer breakwater had been determined upon, this sand catch pier was to form part of the southern limit of the harbor, a short breakwater at the mouth of Buffalo creek. It was meeting the end of the sand catch pier to form the remainder of the southern boundary. This proposed harbor at the time was deemed of ample proportions for all the needs of Buffalo for all time to come. It would have been about 1½ miles long and one-half mile wide, which, of course, included the shallow as well as the deep water. Major T. W. Symons, Corps of Engineers, U. S. A., one of the most accomplished and widely known of the engineer officers, was placed in charge of the Buffalo district in 1895.

Major Symons was not long in perceiving that the proposed harbor was entirely inadequate, even for the present as well as the future needs of Buffalo's rapidly growing commerce, especially after the construction of the immense plant of the Lehigh Valley at Tifft Farm, which demanded an outlet to the lake, and which could not be accomplished, for want of sufficient outside protection. The admirable locations which the locality about Stony Point offered for manufacturing purposes, demanded recognition at the hands of the Government. The extension of the breakwater to Stony Point was due to the untiring and energetic efforts of Major Symons.

With the completion of the Stony Point extension and of that which is promised within the present year, Buffalo will have the proud distinction of possessing the longest line of breakwaters in the world. The distance from the north end of the north breakwater to the shore end of the Stony Point breakwater is 4⅜ miles. With the Black Rock harbor included, Buffalo has thus a harbor exceeding five miles in length, and over one-half mile in width, certainly the most magnificent harbor on the lakes if not in the world. With the harbor finally enclosed and made safe from encroaching seas, the tendency will be the building of outside docks, wharves and piers similar to those in the port of New York, in fact, the congestion now existing in the contracted channels of Buffalo creek and the city ship canal now demands it.

What is usually called the old breakwater, was begun in the year 1869, the first crib having been sunk on June 7 of that year. This breakwater is a little over 7,600 ft. long. The substructure consists of timber cribs filled with stone. These cribs are 50 ft. long and from 34 to 38 ft. wide, and generally 22 ft. deep, the water ranging from that depth up to 30 ft. deep. In water over 22 ft. deep, the cribs rest upon a foundation of rubble stone built to have that depth of water over it. Visitors to the breakwater may have noticed that near the northern end there is a section of irregular width. This deformation was caused by the bad bottom existing here, the bed of the lake consisting of soft mud, which was not able to support the heavy cribs with their stone filling, causing them to settle unevenly and also out of line. Their position after settlement was not disturbed, but the proper level was rectified by placing suitable irregular shaped cribs on top, and the alignment was also modified by driving piles. Subsequently on the adjoining work, the mud was dredged out and the resulting trench refilled with gravel, forming a stable foundation. Fortunately the extent of the mud was not great and the remainder of the cribs were placed on a rubble stone foundation resting directly upon the lake bottom. The superstructure was also built of wood, which has been replaced with concrete, on the northern end, while the southern end, being of more recent construction, is still sound, but upon decay will be repaired in a similar manner.

Owing to the inevitable settlement of the timber cribs, when built upon a yielding foundation, it is not feasible to place a concrete superstructure on them at the beginning, since the ultimate result would be the cracking of the concrete by the settlement of the cribs and its final disintegration and dissolution. As the life of the timber superstructure is about 15 years, it is safe to assume that the cribs will have settled to an unyielding bearing in that time. The extension of the breakwater to Stony Point is now being prosecuted vigorously under the direction of Major Symons. The extension consists of two types of breakwater; one type, the so-called rubble mound or stone breakwater, 7,260 ft. long, and the other type the timber crib breakwater, of which there is 5,600 ft.

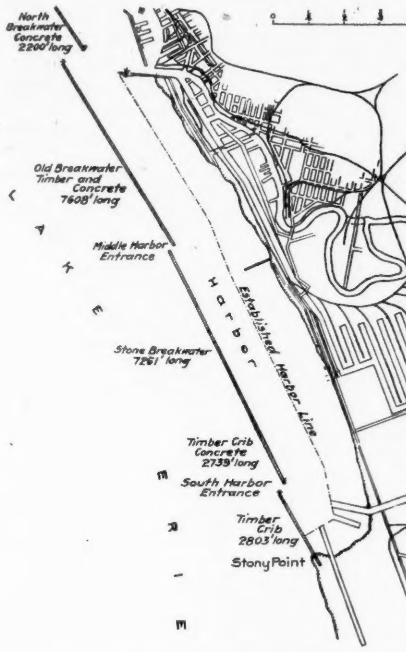
The stone breakwater consists essentially of a core of gravel, protected on both the lake and harbor sides by a heavy covering of rubble stone, from 6 to 12 ft. thick. The gravel is brought up to within 10 ft. of the water surface where it is covered by rubble stone. Beginning at 10 ft. below water level on the harbor side and 15 ft. below on the lake side, the whole structure is capped by immense blocks of limestone, weighing from 7 to 17 tons. The width of the stone breakwater at the bottom is 135 ft. It rises 12 ft. above water level, the top being 14 ft. wide, and has thus a total height of 42 ft. The length of this section of breakwater will be 7,260 ft. The slope of the lake side of the stone breakwater is comparatively flat, the lower portion, or that part lying between 15 and 30 ft. of water, being 1 on 1½. Between the depth of 15 ft. below water and 3 ft. above water the slope is 1 on 2½, and the remainder of the lake slope is 1 on 1½.

In the construction of this stone breakwater, 250,000 cu. yds. of gravel will be needed for the hearting or core, and over 650,000 tons of rubble stone to cover this gravel, and also to serve as a foundation for the large capping stone. This capping will require over 290,000 tons of stone. The gravel all comes from the bed of the Niagara river near the International bridge, just off Squaw Island. Much of the rubble stone comes from quarries along the line of the Erie Canal, both at Lockport and near Albion,

*From a paper presented before the Union Terminal Railroad Branch of the Y. M. C. A., Jan. 12, by Mr. Emile Low, U. S. Assistant Engineer.

and also from the Canadian quarry of the contractors, Hughes Bros. & Bangs.

The stone from the quarry is brought to the scows (which transport it to the breakwater) by a narrow gage railroad built for that purpose. A loading dock extends



Plan of Breakwater System, Buffalo Harbor.

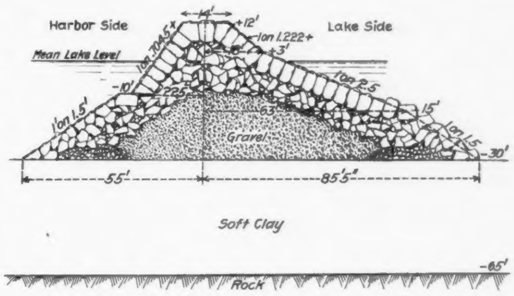
from the shore out into the lake about a quarter of a mile, at the end of which the derricks which transfer the stone from the cars are located.

On the arrival of the blocks of capping stone at the breakwater they are placed into the work by means of large floating derricks, especially built for this work. As the laying of the blocks begins about 15 ft. below water surface, and as they are required to be laid with great regularity, an appliance called a water telescope is used to assist in the operations. By the use of this instrument the exact position of every stone can be seen, and the work when completed can be classed as a giant Belgian block pavement. The blocks of stone being thus closely laid together, and thoroughly keyed, especially at the top, are so firmly bonded that it can be safely asserted that no storm occurring on Lake Erie would ever dislodge them.

Although gravel existed in large quantities in the bed of the Niagara River, below Ferry street, the problem of transporting the same to the breakwater site was a serious one. This was on account of the swift current in the river, especially opposite the city water works crib, where the current runs at the rate of from five to seven miles per hour. The large harbor tugs were first employed for towing, but these proving ineffectual, some large tugs were sent down from the Detroit River, but were also unable to combat the current. As a last resort the contractors were compelled to build a tug of large dimensions and great power which solved the problem of towing the large scows, containing 500 cu. yds. and more.

The structure adjoining the stone breakwater on the south is a timber crib structure, filled with stone, and is about 2,800 ft. long. The breakwater jutting out into the lake from Stony Point is also of the same type, and is of the same length. Between the two an opening called the South Harbor entrance is left. This opening is for the convenience of shipping and is 600 ft. wide. Owing to the unstable material forming the lake bed in this locality, it was not deemed advisable to place the crib work directly on the same. Instead a trench was excavated down to bed rock. The trench was from 50 to 60 ft. wide on the bottom and from 80 to 100 ft. wide on top. The bed rock in many places was 70 ft. and over below the water surface. As the ordinary dipper dredges are unable to dig in such a depth of water, a dredge of a different design and known as the clam shell was built. It can be said that this dredge was the largest and most efficient that ever operated on the Great Lakes. The clam, or bucket, has a capacity of 10 cu. yds. and weighs over 30,000 lbs. The resulting trench is filled with sand and gravel up to the level of the original lake bottom, and furnishes thus an unyielding foundation for the rubble stone layer and superincumbent cribs. This seems somewhat at variance with the Biblical injunction, which admonishes us all to build on rock and not upon the yielding sand.

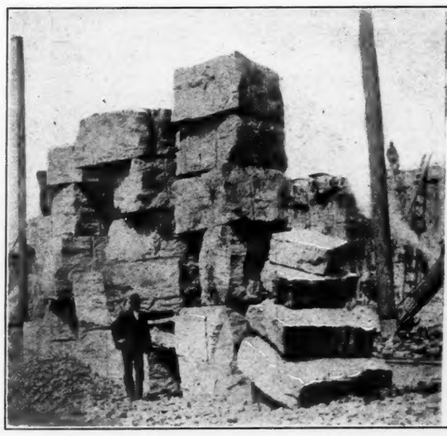
The cribs forming the superstructure of the South Harbor and Stony Point breakwaters are built of hemlock timber except the top courses, which are of pine. The superstructure is also of pine. The hemlock came from



Cross-Section, Showing Construction.

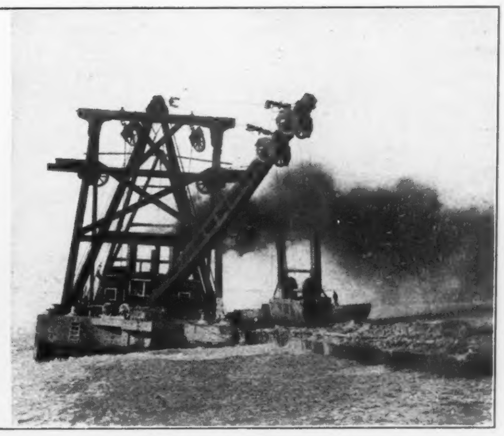
Pennsylvania, while the pine was obtained from Michigan. The larger cribs of the Stony Point breakwater are 60 ft. long, 36 ft. wide and 22 ft. high, and contain nearly 98,000 ft. B. M. of timber, and over 14,000 lbs. of bolts and spikes each. The completed breakwater contains nearly 5½ millions ft. B. M. of timber and three-quarter million lbs. of bolts and spikes. The cribs in the South Harbor breakwater are 180 ft. long, 36 ft. wide and 22 ft. high, and contain over 280,000 ft. B. M. of timber and nearly 40,000 lbs. of bolts and spikes each. The completed breakwater contains nearly 6½ millions ft. B. M. of timber, and nearly 900,000 lbs. of bolts and spikes. The two breakwaters thus contain about 12 million ft. B. M. of timber. Assuming that an acre of forest land would cut 25,000 ft. B. M. of timber, the quantity used in these two breakwaters would represent the product of nearly 500 acres.

The location in which the South Harbor breakwater is



Quarried Capping and Revetment Stone—Canadian Quarry.

Revetment Stone, Being Placed Under Water on Lake Side of Stone Breakwater.



Dredging in 70-ft. of Water for Gravel Trench.

South Harbor Breakwater, Showing Original Timber-crib Superstructure, Replaced by Concrete, in the Distance.

Concrete Foundation Courses, South Harbor Breakwater.

Superstructure of Stone Breakwater.

Stone Breakwater.

Construction of Superstructure.

built is subject to tremendous wave action during violent storms, which are usually from the southwest and west. The tendency of these storms from the west is to raise the water level as much as 8 ft., and east winds will depress it 5 ft., making an extreme variation of 13 ft. in the water level. Soon after the South Harbor breakwater was finished, we had one of these gales—it might more properly be called a hurricane—which did more or less damage to the timber superstructure of the breakwater. The waves upon striking the vertical face of the breakwater rose to a height, variously stated to be from 100 to 150 ft. This damaged portion is now being rebuilt with concrete, from designs by Major Symons. The main features of the work are the enormous concrete blocks, those on the lakeside weighing 19 tons, while those in the interior of the work and on the harbor side weigh 15 tons.

The timber cribs on which these blocks rest are cut down 2 ft. below water level, which keeps the timber always under water, and thus practically unperishable, as has been frequently demonstrated. The reason that the concrete is not placed directly on the timber, and is not made in place, is that the water is constantly in motion, mostly from the influence of the winds, and this action would tend to wash out the cement and render the concrete useless. The lower course is therefore made of blocks, which are built in the open, and allowed to set hard, and are then placed in position partly submerged. The spaces between the blocks are filled with rubble stone, on top of the blocks are built heavy concrete walls, between which rubble stone are also placed. A heavy top of concrete is placed over all, completing the structure. Owing to the vertical walls of the crib work, boats can moor at this breakwater, which cannot be done at the stone breakwater. With the long stretch of timber breakwater ample provision for mooring is supplied.

With the final completion of the breakwater in the immediate future, and the resulting establishment of one of the most magnificent harbors in the world, combined with the building of extensive manufacturing plants within its boundaries, there is no doubt that the commercial and industrial importance of Buffalo should not advance with more rapid strides than ever before.

Experimental Studies of the Causes of Brittleness of Steel.*

BY CH. FREMONT.

It is known that certain grades of iron and steel, classed as very satisfactory by tension tests, are not found so in bending tests with grooved bars. A certain metal, tested by tension, had a good elongation, a well pronounced reduction of area, and the area of the diagram, which Poncelet calls *résistance vive*† of rupture, indicated a considerable expenditure of energy. The same metal, in a bar grooved by a saw would break off by bending practically along a plane; the volume affected by the deformation would be very small and the *résistance vive* would be small.

The brittleness may be sufficiently pronounced, to be shown by static bending, as will be seen from the following tests on two specimens of steel designated numbers 9 and 16, and coming from different makers. Each was tested by tension, in the direction of the fiber in three mechanical laboratories. The results are given below:

Steel No. 9.

	Test No. 1. K	Test No. 1. Lbs.	Test No. 2. K	Test No. 2. Lbs.	Test No. 3. K	Test No. 3. Lbs.
Elastic limit	31.25	(44,460)	......		29.9	(42,540)
Ult. strength	60.3	(85,800)	59.35	(84,440)	57.2	(81,400)
Elongation, p. c.	23.5		23.25		28	

Steel No. 16.

	K	Lbs.	K	Lbs.	K	Lbs.
Elastic limit	33.25	(47,300)	......		40.7	(57,900
Ult strength	60.7	(86,360)	59.25	(84,300)	57.2	(81,380)
Elongation, p. c.	22		19.75		22.20	

The width of the bars did not permit direct transverse testing. I have since determined indirectly the resistance crosswise by shearing and at the same time verified the resistance lengthwise. I have thus found:

Steel No. 9.

Lengthwise.—Resistance in shear 30.31k (43,120 lbs.), from which resistance to tension, 60.62k (86,250 lbs.)

Crosswise.—Resistance in shear 28.14k (40,040 lbs.), from which resistance to tension 56.28k (80,080 lbs.).

Steel No. 16.

Lengthwise.—Resistance in shear, 29.77k (42,360 lbs.), from which resistance to tension, 59.54k (84,710 lbs.).

Crosswise.—Resistance in shear, 28.14k (40,070 lbs.), from which resistance to tension, 56.28k (80,080 lbs.).

Fig. 1 is a half size reduction of the tension diagrams superposed as registered by the machine. The full size ordinates give the resistances to a scale of 284 kilograms per sq. millimeter (15,900 lbs. per sq. in.); and the abscissas are elongations. The full curve corresponds to steel No. 9, the dotted to steel No. 16. It is seen that in tension the two steels have a fair elongation for their hardness; their co-efficients are comparable, with a little more ductility and *résistance vive* for No. 9.

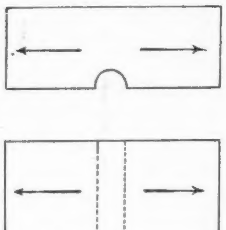


Fig. 16.—Diagram of Grooved Test Piece Under Tension.

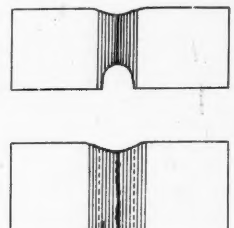


Fig. 17.—Rupture of Test Piece Shown in Fig. 16.

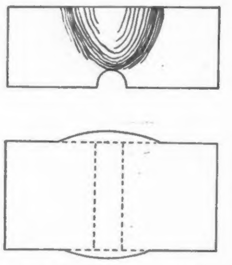


Fig. 18.—Diagram of Reinforced Grooved Test Piece.

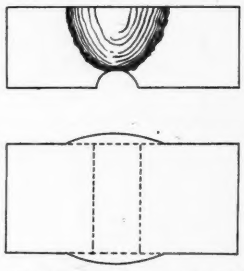


Fig. 19.—Rupture of Test Piece Shown in Fig. 18.

Now let us take the same metals by static bending; the bars are, as are all I have used, 30 mm. (1.18 in. long by 10 mm. (.39 in.) wide and 8 mm. (.31 in.) thick; they are grooved opposite to the point of impact, by a saw line, 1 mm. (.04 in.) wide and 1 mm. (.04 in.) deep.

The figures 2 to 5 give the diagrams for bending. Fig. 2 is the diagram from steel No. 9 tested crosswise; Fig. 3, steel No. 9, tested lengthwise; Fig. 4, steel No. 16, tested crosswise; Fig. 5, steel No. 16, tested lengthwise. For steel No. 9 the rupture was abrupt, with a small amount of work, 2 kgm. (14.4 ft. lbs.) crosswise and 3.5 kgm. (25.2 ft. lbs.) lengthwise. For steel No. 16, in which the ductility in tension was a little less, the work of rupture by static bending is notably greater, 4 kgm. (28.8 ft. lbs.) crosswise and 9.5 kgm. (68.5 ft. lbs.) lengthwise.

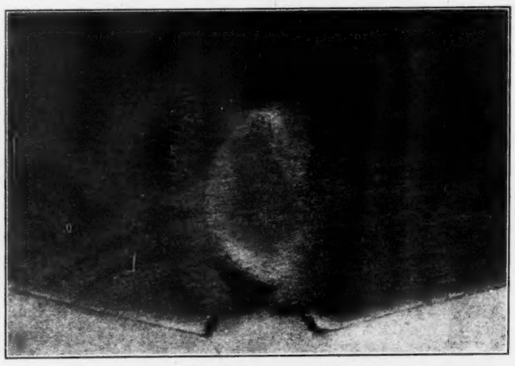


Fig. 11.—Bending Test of Polished Specimen Showing Deformations.

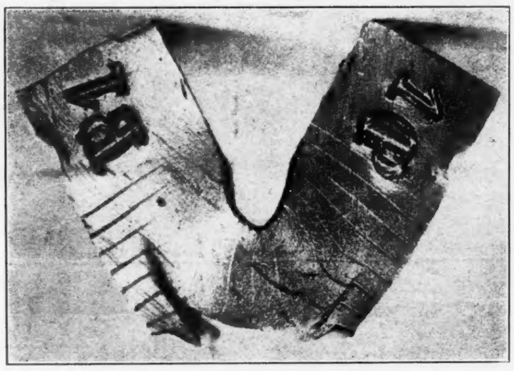


Fig. 13.—Character of Break with Non-Brittle Steel.

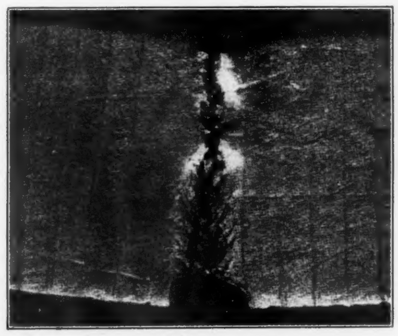


Fig. 14.—Character of Break with Brittle Steel.

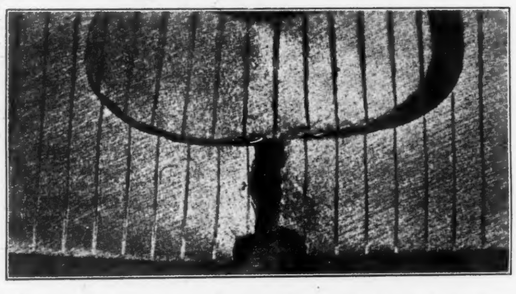


Fig. 22.—Character of Break When Hard Block is Inserted in Compression Side.

*Translated from Bul. Soc. A'Encour., February, 1901, by C. L. Crandall, Cornell University.

†Resilience.

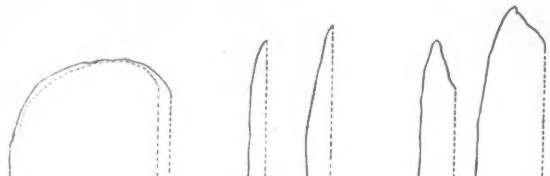


Fig. 1. Fig. 2 Fig. 3. Fig. 4. Fig. 5.

Tension Diagrams.

Fig. 6.

Static Bending.

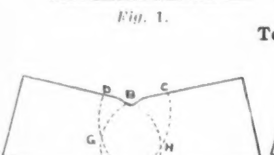


Fig. 12.—Diagram of Deformations Shown by Fig. 11.

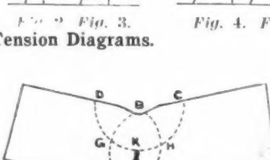
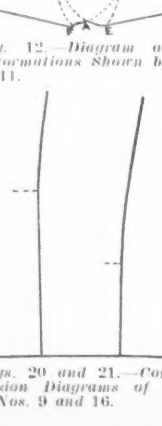


Fig. 15.—Diagram Showing Deformation of Ordinary Quality of Steel.



Figs. 20 and 21.—Compression Diagrams of Steels Nos. 9 and 16.

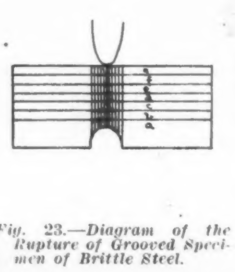


Fig. 23.—Diagram of the Rupture of Grooved Specimen of Brittle Steel.

Fig. 6 is the diagram for static bending of a similar steel [60 kg. (85,370 lbs.) tensile strength and 20 per cent. elongation] but not brittle. All things being equal, the rupture is made progressively with an expense of 21 kgm. (151.4 ft. lbs.). Another similar test piece of the same steel, tested in bending by shock required 23 kgm. (165.8 ft. lbs.). The four test pieces, crosswise and lengthwise of the two steels Nos. 9 and 16, broken by static bending are shown in Fig. 7 magnified 5 diameters.

It is seen that the rupture produced follows a plane passing through the middle of the groove, and that the volume of the metal affected, and the lateral deformations are small, especially for No. 9. When the brittleness is not made sufficiently apparent by static bending, it may be made evident by impact tests. Brittleness is apparent, however, only above a certain velocity of impact. Thus, six grooved test pieces of the same steel and of the same uniform type, marked respectively 1, 2, 4, 5, 6, 3, were broken by bending under velocities of 1 meter (39.37 in.), 1.10 m. (43.3 in.), 1.20 m. (47.24 in.), 1.30 m. (51.18 in.), 1.40 m. (55.1 in.), 1.50 m. (59 in.) respectively.

The photographs are shown in Fig. 8. The first five test pieces have undergone deformations differing but little; the sixth alone broke abruptly; the metal had become brittle only for a velocity of fall of 1.50 m. (59 in.).

To explain these facts, one supposes that the transmission of force is not instantaneous, but depends upon the velocity of impact. The volume of metal affected will depend upon the velocity and diminishes inversely with it. Consequently, in the product of resistance by deformation, the factor "deformation," decreases when the velocity of the blow is increased, the product itself diminishes and the rupture takes place with less work. M. Cornut expressed himself as follows upon this subject in 1889*: "If we suppose that a piece of steel, iron, etc., is submitted to a slow and progressive force, the strain is transmitted successively from molecule to molecule, in such a way that all the molecules of the body are sensibly submitted to the same effort. Where the effort is sudden, all the molecules of the body do not have time to distribute this force, and the first molecules touched can be torn apart, while the other molecules would sustain no apparent shock. Metals can then present very different qualities when they are submitted to slowly applied forces or to suddenly applied ones."

In support of this opinion, one may take a well known experimental fact: the influence of velocity upon the results of tension tests. It is known that an increase of speed slightly increases the resistance and slightly diminishes the elongation. But these variations do not extend far and are not proportional to the speed. Tension tests with the aid of explosives furnish figures sufficiently near those of ordinary tests. Even by bending, with good metals, the results are independent of the speed.

Fig. 9 is a photograph of a test piece marked P (pres-

*Etude sur les essais des fers et des aciers.

sure) and tested by static bending. Fig. 10 is a photograph of a test piece cut from the same metal. It bears the mark C (shock) and has been tested in bending by shock. In both cases the deformations, which the parallel lines marked upon the bars indicate, are nearly the same as is also the disturbed volume, although the velocities were greatly different. In both cases the amount of work done was practically the same, namely, 25 kgm. (180.25 ft. lbs.). It is thus shown that the assumed opinion, although it may contain a certain amount of truth, is not sufficient in itself. To verify it, let us examine the results of experience.

Take a piece of steel of any quality, with the same form of grooved bar, and begin to bend it as shown in Figs. 11 (photograph) and 12 (diagram). If the lateral surfaces were sufficiently polished, the deformations would be easily seen. They are formed by the superposition of two elementary deformations, one by depression, the other by enlargement. The depression EFGBH (Fig. 12) is nearly an ellipse in which the major axis coincides with the line AB joining the point of impact with the groove. The enlargement is a portion of an ellipse having the same major axis as the preceding, but the extremities of the major axes do not coincide. These are for the ellipse in depression, the point of impact B and a point placed a little below the groove; for the ellipse in relief the bottom A of the groove and a point placed near that of impact. The two ellipses have a common part, AGBH, which is itself quite elliptical and in which the deformations by depression and by elevation are superposed and neutralized in part. These results show that the maximums of deformation may be a depression, or elevation, and are localized at the limit of the common ellipse and will be transferred from one part by two anticlinal lines, BG, BH running from the point of impact and from the other part by two synclinal lines, FG, EH starting in the vicinity of the groove. With continued bending, rupture naturally follows the weak lines, that is to say, the synclinal lines, with progressive stretching along these lines, great reductions of area, and great expense of work. Finally the lower part of the bar bends without rupture. It is thus with non-brittle steels of which Fig. 13 is a specimen.

In the case of very brittle steel (Fig. 14 or 8-3) the enlargement ellipse is reduced almost to nothing and rupture occurs from top to bottom by tension, following the plane which joins the groove with the point of impact. The deformations to the right and left of the plane of rupture are reduced to a small stricture throughout nearly all the length and rupture is abrupt with a very small expenditure of energy.

For steels of intermediate quality, the phenomena which accompany bending tests are a combination of those which are found in the extreme cases. The enlargement zone CBDGKH (Fig. 15) is stopped at K between the groove and point of impact. Under these conditions, rupture begins by tension, almost as for brittle steels, and continues as far as K. There it meets the anticlinal lines KC, KD, and follows one of them, or both, according as the conditions are more or less symmetrical for the two parts (Figs. 8-1, 8-2, 8-4, 8-5, 8-6). However, as the formation of the anticlinal line in the part HG (Fig. 15) is opposed by the superposition of the depressed zone, it may happen that the rupture will follow the prolongation of A.K.

If we take a test piece of rectangular section and cut upon one face a semi-circular groove (Fig. 16) and then submit it to tension, it will break at its weakest section, which is in the center of the groove and along a plane perpendicular to the axis (Fig. 17). A constriction, proportional to the ductility, appears upon the three ungrooved faces, but will be limited to the width of the groove. If, in the preceding test piece, the two lateral faces are reinforced opposite the groove by a semi-elliptical enlargement (Fig. 18) and the reinforced test piece submitted to tension, rupture could no longer follow a plane perpendicular to the axis, on account of the supplementary resistance supplied by the enlargement; the deformation will then be around the enlargement and this time we will have two strictures, one on each side of this enlargement, and rupture will follow one or the other of these strictures (Fig. 19).

In the bending tests of grooved bars, the artificial enlargement which we have assumed for the tension test piece is naturally produced by the deformation of the compressed zone. And it is seen at once as a consequence of the facts of observation and experience related above, that a steel will be more or less brittle, under determined conditions, according as under these conditions the enlargement zone of the compressed side is more or less small or flat. In other words, the results of the test will depend upon the position of the point K, the vertex of the ellipse of compression (Fig. 15) and of the projection of the enlargement beyond the primitive plane. Should the point K extend as far as A (groove) or beyond, the metal will not be wholly brittle; should the point K remain in the proximity of B, the metal would be extremely brittle; it would be of intermediate quality for the intermediate positions of K. The projection of the enlargement is of no less importance than its position. All of this seems a flagrant contradiction of the accepted ideas upon the existence and position of the neutral fibers which are assumed to form a plane parallel to the compression and tension faces of the test piece and equidistant from them. It is true that these ideas cannot be extended indefinitely beyond the elastic limit. But it is certain from the observation of facts that within the limits of permanent deformations, the surface of the neutral fibers is neither parallel to, nor equally distant from the faces. The areas of depression and extension are not limited; but intersect and the surface of the neutral fibers is the locus of the points where the depression is equal to the elevation. As to the position of this surface, it can vary with the conditions of the test, and other things equal, it varies with the quality of the metal. The nearer the neutral fibers approach the compression face, the more brittle the steel; and reciprocally, the nearer the neutral fibers to the tension face, the less brittle the steel.

The fact that the neutral surface is not, or cannot be, at equal distances from the compression and tension faces of the bar submitted to bending, clashes with another accepted idea, namely, that of the equality between the elastic limits of compression and tension. We have just seen that with brittle steels the zone enlarged by compression remains confined to the vicinity of the point of impact and presents only a very small projection. In tough steels on the contrary, the zone enlarged by com-

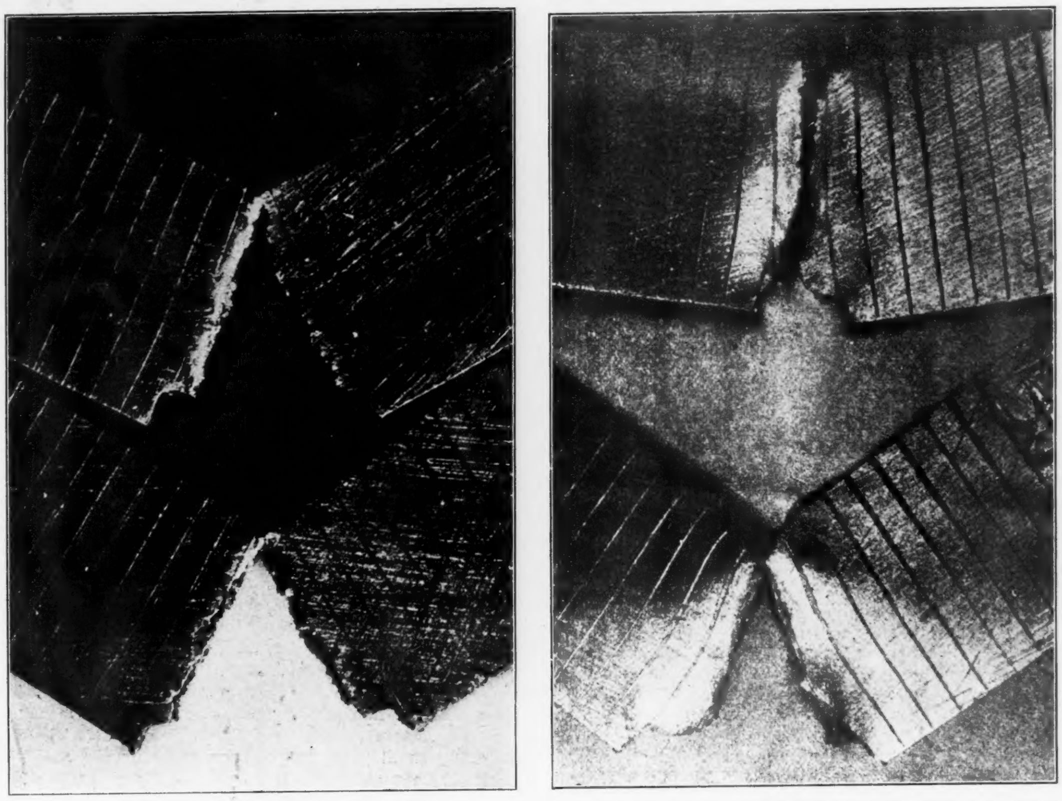


Fig. 7.—Steels Nos. 9 and 16 Broken by Static Bending.
(*Magnified 5 diameters.*)

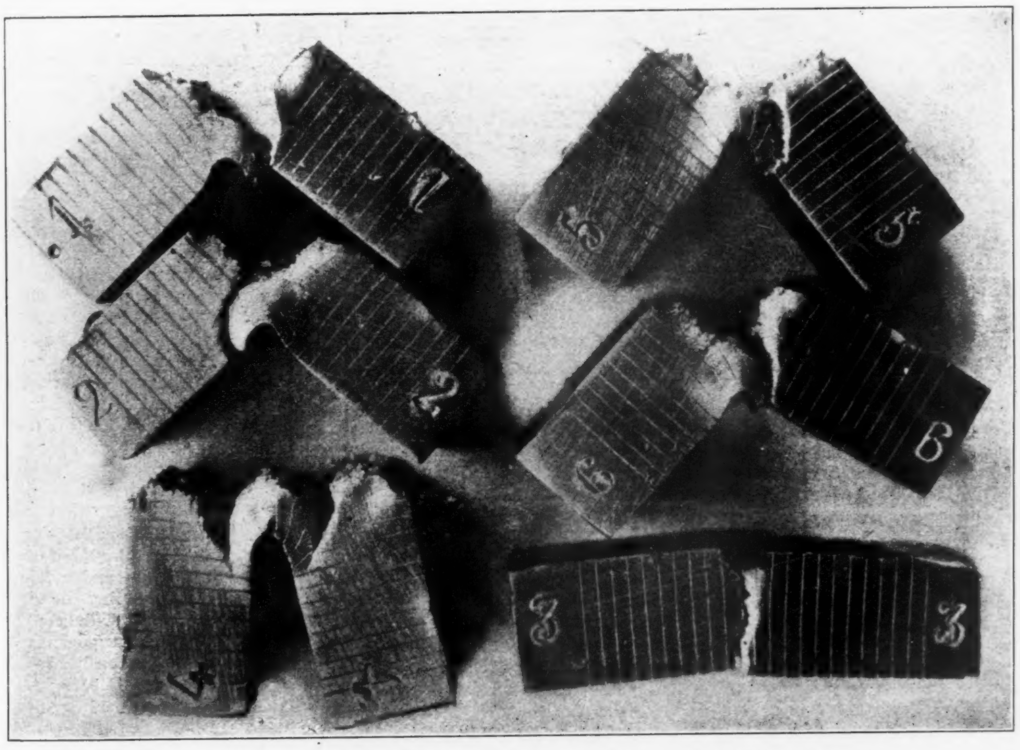


Fig. 8.—Tests with Grooved Specimens at Different Velocities of Impact.
(*Magnified 2 diameters.*)

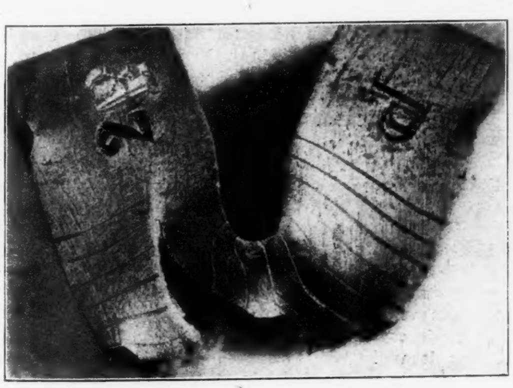


Fig. 9.—Test Piece Broken by Static Bending.
(*Same material as in Fig. 10.*)

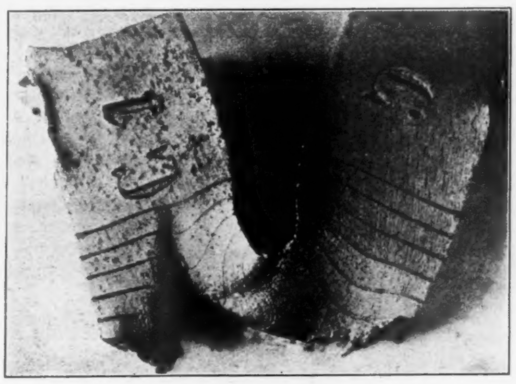


Fig. 10.—Test Piece Broken by Shock.
(*Same material as in Fig. 9.*)

pression extends to the vicinity of the groove, and makes a projection.

I have tried to verify experimentally the existence of greater or less differences between the elastic limits of tension and compression. I have determined the elastic limit in compression of the two steels No. 9 and No. 16, in two different laboratories. The results are shown by Figs. 20 and 21. I find thus 41.60 k. (59,190 lbs.) for the elastic limit in compression for No. 9, and 23.40 k. (33,282 lbs.) for that of No. 16. The elastic limits in tension were respectively 29.90 k. (42,540 lbs.), and 31.25 k. (44,460 lbs.) for No. 9, and 33.25 k. (47,300 lbs.) and 40.70 k. (57,900 lbs.) for No. 16. The elastic limit of No. 9 in compression is much greater than the elastic limit in tension, and the metal is very brittle. For No. 16 the difference is in the other direction, even if one chooses the smaller value of the two (rather divergent results) found for the elastic limit in tension. This metal is not as brittle as the other.

The following table* was prepared by M. Hadfield, and shows the results of his experiments on alloys of iron and nickel. The elastic limits of tension and compression are brought together in two columns.

Chemical composition. C.	Mn.	Ni.	Elastic limits in compression.	Tension tests. Elastic limit.	Rupture.	Elongation per cent.
A. .0.19	0.79	0.27	22	19	31	35*
B. .0.14	0.75	0.51	22	20	30	36*
C. .0.13	0.72	0.95	20	25	33	31*
D. .0.14	0.72	1.92	27	26	34	33*
E. .0.19	0.65	3.82	28	28	37	30*
F. .0.18	0.65	5.81	40	28	41	27
G. .0.17	0.68	7.65	40	31	49	26†
H. .0.16	0.86	9.51	70	42	85	9†
I. .0.18	0.93	11.39	100	65	94	12†
J. .0.23	0.93	15.48	80	55	94	3†
K. .0.19	0.93	19.64	80	47	71	7†
L. .0.16	1.00	24.51	50	32	77	13†
M. .0.14	0.86	29.07	20	25	38	33*

* Not brittle. † Very brittle.

Without having very precise data upon the brittleness of this series, one knows in a general way that with forged bars the alloys with a small amount of nickel are not brittle, that the brittleness appears with a sufficient amount, passes through a maximum at about 14 per cent and disappears at about 27 per cent. The sign and amount of the differences between the two elastic limits agrees well with this data. A steel is brittle (that is to say, breaks abruptly in bending with a small expenditure of work) or not brittle (that is to say breaks progressively, requiring an amount of work proportional to that required for rupture by tension) according as the ratio of the elastic limit in tension to that in compression is less or greater than unity. However, this simple statement is probably too positive, because the elastic limits determined under the ordinary conditions of static tests are not exactly applicable to tests by shock and upon grooved bars. It is sufficient to say that a steel is or is not brittle according as its capacity for deformation by compression exceeds or not exceeds its capacity for deformation by tension under the conditions of the test.

All possible artifices capable of revealing brittleness always restrain the compression, or favor the tension. For example, if a hard slightly deformable block is placed in the compression side of a bar of non-fragile steel (Fig. 22) the metal will break by tension, with a small amount of work.

The function of the grooves is easily explained. (I do not speak of their form, which will be the subject of another paper.) The grooved test piece (Fig. 23) can be considered as the sum of a series of elementary plates, a, b, c, d, etc., which will be submitted successively to tension; but the first test piece a, the weakest, will have a very restricted elongation, limited as a maximum to the width of the groove. If then the deformation by compression extends only as far as the groove to reinforce the opposite metal, this first test piece will break along a plane passing through the middle of the groove. The greatest effort which determines rupture is concentrated upon a section so much diminished, and the break will spread instantaneously until it is arrested by the enlargement due to compression, if this enlargement has been able to form. In fact, the groove has favored rupture by tension. In the absence of the groove, the elongation of the first elementary test piece is not localized; but it may extend over the whole face. Here again the metal would be brittle if the deformability by compression is relatively small. The greatest part of the total deformation is due to tension, but the conditions favor brittleness.

To explain the influence of the velocity of the shock, one may assume the current idea, that the disturbed volume is proportional to the velocity of impact. The zone raised up by compression is also decreased; but for this influence or effect it is necessary that the metal be near a certain point of passage, in order that small variations may displace the surface of the neutral fibers. If the metal is very good or very poor, its properties are too marked for the speed to affect the results.

Other influences, known factors of brittleness, will some day be explained by the relative variations of deformability in tension and compression: thus the effect of cold, of work at a blue heat, and of vibrations and fatigue.

These experiments show that the tests by tension alone, or the tests by compression alone, do not define a steel. Both tests are necessary, and flexure which unites them is a complete method of testing, on condition that one gives to it by well chosen devices the proper sensitiveness, neither too great (all steels appear brittle) nor too small (brittleness disappears). This can be obtained by grooves of appropriate forms and dimensions.

* Proceedings of the Inst. of Civ. Engrs., Vol. 138, London, 1898-1899.

A New Yard Design.

BY W. C. CUSHING.

[WITH AN INSET.]

In the Jan. 4, 1901, issue of the *Railroad Gazette*, appeared an article by the writer, entitled, "Method of Procedure in Remodeling Freight Yards," and, since that time, the railroads of the United States have experienced the two most prosperous years of their history. Prosperity means a very heavy car movement, and the facilities of most railroads have been heavily taxed, so that the operating officers have had an opportunity to observe the merits and defects of their divisional and terminal yards, which in many cases limit the car movement.

During this heavy business the writer had the opportunity to observe the operation or working of a yard, which is, in substance, a fac simile of design 2 of the "Yard and Terminal Committee" of the American Railway Engineering and Maintenance of Way Association, and is illustrated in their report published in the Association Proceedings, Vol. 3, for 1902.

It is the intention of this paper to point out some of the defects in the committee's design, and present for consideration a plan designed by the writer to take its place, and at the same time provide for future growth in business.

The committee's plan has a standing car capacity of 6,200, but the writer estimates that it is capable of passing through it only about 24 trains, or 1,500 cars a day. The yard of similar design, which will be styled "A," observed by the writer, passed through it, for every day of the year 1902, 2,121 cars, and it is, at the same time, smaller by about 1,200 cars. The maximum number of cars handled in one day was about 2,750, and this means that the car movements or operations were twice that number, or 5,500, because every car which was brought in at one end by an engine was taken out at the other by a second engine. This greater movement was accomplished only by using what is marked on the committee's plan, storage yard, for an additional receiving and classification yard, and by the assistance of gravity in one direction. In other words, one switching engine, working over one throat, in each direction, could not handle the business. The lesson to be learned from this is, that a level, or nearly level yard of the size designed by the committee is impracticable, because its operation is very slow. The committee mentions the summit or grade feature as an incident rather than a necessity in its construction (Am. Ry. Eng. and M. of W. Proc. Vol. 3, page 259), and the writer desires to impress upon his readers that assistance by gravity is absolutely necessary for rapid work in a large yard. Yard "A," above referred to, is now being provided with additional gravity assistance as fast as possible.

A second mistake in the committee's plan is the extreme length of ladders. It has a ladder length of 40 tracks, whereas less than half that number is now observed as the best practice. The writer believes that about 35 or 36 classification tracks are as many as should be provided for one receiving yard, to be worked by one engine, and that when the business is heavier than that, or a greater number of classifications are required, a second receiving yard should be provided, and an additional classification yard, to be worked by a second engine.

The third mistake in the committee's design is the length of the classification tracks, and the absence of departure tracks in a yard of this size. It is utterly impossible either to tail switch, or to pole cars into classification tracks of this length without several extra operations of the engine, if the yard is level, and, to obtain the assistance of gravity, even by the "Dos d'âne," or "Hump," may be very costly, because a certain amount of descending grade must be carried to the extreme end of the classification tracks. Moreover, in order not to impede the breaking up of trains, it is necessary to have departure tracks to provide against the contingency of late locomotives. By having, therefore, an abundance of short classification tracks, and a departure yard of ample capacity, the actual working place of the yard is kept as free and unimpeded as can be. These classification tracks should not, by any means, be as short as those in the committee's design No. 1, viz., 12 cars, but should be, approximately, half the length of the departure tracks. In the case of a division with low grades, where heavy drag trains of 80 cars can be hauled, the length of the classification tracks should be about 40 cars, because short fast freights can be despatched direct from the classification yard without doubling over when desirable to do so.

There should be plenty of running, or open tracks, for yard and light engines, so that they will keep out of each other's way, and be enabled to run quickly from one part of the yard to another. This is especially valuable for night work, when the most of the accidents occur. The committee's plan is defective in that respect.

It is now a pretty well established fact that the assistance of gravity is absolutely necessary for the quick and economical switching of a large yard. The ideal plan is to have a uniform grade from one end to the other, such that cars will maintain a uniform speed throughout when once started, or at least will not be too much accelerated. The grade necessary for this is something more than 1 per cent., but a different grade is required in winter from that desirable in summer, because the cars do not run so freely in winter time. Consequently it is difficult to settle upon the exact grade. Probably the receiving tracks should be on a steeper grade than the rest of the yard, so that cars will start upon the releasing of the brakes. They do not start quickly enough, however, unless it is very steep, and therefore an engine is usually employed in this country to start the cars. It is generally difficult and expensive to obtain a location of this kind for a yard, and the next best thing is to have recourse to the "Dos d'âne," "Hump," or "Summit" plan. The proper curve for the grade of such a yard approximates a spiral, or a portion of a parabola (simply as an illustration), and its disadvantage is that car damages are increased, when the classification tracks are pretty well filled with cars. It is the only way, however, to obtain gravity assistance at reasonable cost, when the configuration of the ground does not favor a gravity yard proper. It can be made on level ground without costing nearly so much as the Dresden Yard in Germany, and an ordinary river grade can be reversed without excessive cost. The number of yards built on this plan is increasing and we have had very satisfactory results from actual experience. There are many small yards in the country where the operations can be wonderfully facilitated at a very moderate cost, simply by building a small hump between the receiving and the classification tracks. A yard to which this principle was applied for the westbound direction is illustrated in Fig. 1, and is shown as actually arranged. The switches at the entrance to the classification or delivery tracks are thrown by a set of non-interlocked levers in the upper story of the tower. The operations are conducted very quickly, and, for its size, it has a large capacity. About 1,100 cars in 24 hours, in the westward direction only, have been passed through it, and it is considered capable of handling 1,500 to 2,000 if the classification tracks are kept free by abundance of road power. The number of classifications per train at this point are not nearly so numerous as in the case of yard "A."

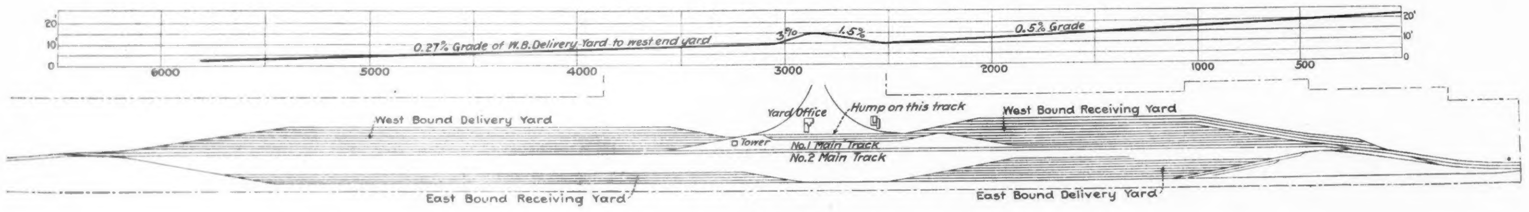


Fig. 1—Gravity Yard for Moderate Traffic.

The writer has designed for a particular location, a yard, illustrated in Fig. 2, on the principles enumerated above, for handling a very large business, and requiring very many classifications. It has a standing car capacity of 12,360, and it is estimated that it will take care of a daily business of 7,000 cars without pushing the work. By working eight engines simultaneously over the humps, it is believed that this number could be increased to 10,000 cars, if there should be enough road engines to keep the classification tracks free.

Speaking of one direction of traffic only, there are two receiving yards of 10 tracks each, from which the cars are to be fed into their respective classification yards of 36 tracks. The length of the receiving tracks is governed by the local conditions, in this case 74 to 90 cars. The classification yards have V shaped ladders with No. 7 frogs on a No. 6 angle, making the ladders only 18 tracks long. When working two yards side by side, it is quite likely that cars of the same classification will be in each, and it is therefore essential that the tracks be so arranged at the lower end, that the cars on any track whatever can be pushed to any track in the departure yard. This has been accomplished on the plan, and the ladder arrangement is such that all of the classification tracks are about the same length, 40 cars. It will be further noticed that one-half of them are absolutely straight, while the other half have but one slight curve, a very important consideration, and the descending grade continues to their ends.

The departure tracks need no comment, except to say, that, as the train pulls out, the caboose runs down by gravity against the rear, and is coupled on. There is room, before reaching the main track outlet, to com-

plete this operation, and the train is ready to enter the main track.

There are plenty of open tracks for engines, and the main tracks are placed on the outside of the yard, so as to diminish the crossing, and they can be reached from the yard only at the interlocking plants at each end.

When storage room is needed, the number of departure tracks should be increased, and the additions used for that purpose.

It is not necessary to build both engine houses till the traffic proves they are necessary, as each can be reached conveniently from either yard.

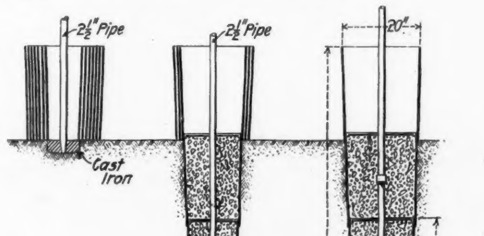
Attention is particularly called to the ash pits and coaling arrangement. In the case of the outside receiving yard, the light engine from the incoming train passes to the ash pit *under the hump* of the sister yard. The latter are arranged side by side, as some engines can be cleaned more quickly than others, and should not be delayed behind a procession. There will be a coaling pocket directly above each pit, which will be fed from a storage bin, in turn kept supplied from hopper bottom cars dumped from the trestle above. This trestle is to have a steep incline, 45 deg. if necessary, and the coal cars will be drawn up by a stationary hoisting engine, operating what is known as a "billy goat" on the Cleveland docks. The "goat" rises from a pit and engages the rear end of the coal car to be hoisted. Loaded cars feed over this pit by gravity, and the empties are disposed of by gravity after having been lowered again to the pit. The coaling pockets should be as nearly as possible at right angles to the ash pits. They are not so in this case on account of the room. Improper and inadequate facilities for cleaning and coaling engines are the cause of a good deal of reduced locomotive mileage, and the problem of designing an efficient plant is a troublesome and very responsible duty.

Placing Concrete Piles by Jetting.

The Raymond system for concrete piles has been described in these columns. (Aug. 15, 1902.) Briefly, it employs an expanding steel core encased in a metal shell, from which the core is withdrawn after the required depth is reached, and the shell filled with concrete. Mr. Raymond has now devised a method for placing concrete piles in sand, silt and material of that nature by use of the water jet.

Referring to the illustrations, it will be seen that the shell is made in sections of equal length. These sections are nested over the spot at which the pile is to be placed. The inner shell is attached to a cast-iron point 10 in. in diameter, and to this point a 2½-in. water pipe, provided with a ¾-in. nozzle, is also attached. Each section of shell is made slightly larger in diameter at its upper end than the lower end of the section next above, the sections being drawn down by the friction between adjoining ends. These shells are made of 22-gage, or lighter, sheet steel. The filling with concrete is done as the shell is sunk, so that by the time the desired depth is reached the operation is practically complete.

In order to hold the shell central on the pipe, a cast-iron spreader is placed at the top of each section. These spreaders are strung on the pipe and are lowered into place, each into its section, before the concrete is put in. The pipe is allowed to remain in the pile.



Placing Concrete Piles by Jetting.

Piles of any reasonable diameter and taper may be obtained by this method. The illustrations show three stages in the process of sinking a 56-ft. pile having a diameter at the top of 20 in. The shell is in seven sections, each eight ft. long. However, the length of pile which may be obtained is only limited by the thickness of the stratum of material through which the water jet will penetrate. A short time ago an experimental pile was put down in the Missouri River, near Omaha, to a depth of 75 ft. This pile had the same maximum and minimum diameters as those given in the illustration, the jet pressure required being 40 lbs. per sq. in.

The patents are owned by the Raymond Concrete Pile Co., Chicago.

The Rail as a Girder.

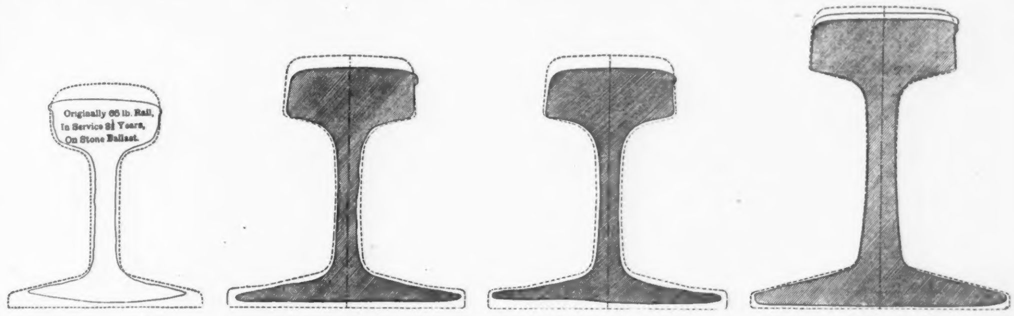
BY DR. P. H. DUDLEY.

It is only 20 years ago that I was advocating the necessity of increasing the stiffness of the rail as a girder. I had then passed over, with my track indicator, rails under all conditions of service and wear, and had noticed the form of sets which characterized all of the sections, on different lines. Complete diagrams of tracks had been made from New York to Chicago and return; from Boston to Portland, Me., over two different lines, and return; from Jersey City to Washington and return; and several other trips over the same tracks on the Philadelphia, Wilmington & Baltimore. The average undulations were 5 to 6 ft. per rail per mile, while for the rails which had been eight to ten years in service, the undulations were from 10 to 12 ft. per mile. But few miles of track were found, unless of new rails, without nearly every joint giving or permitting shocks to the passing wheels. The receiving ends of many rails were cut out, and all each cross-tie. The round topped head rolled under the passing wheels. The approximate tonnage was 51,000,-000 tons. This rail was removed in 1883, as a few rails in one place oxidized faster on the base, than in the main portion of the tunnel.

Figs. 2 and 3 show the comparative wear and oxidation of the 5 in. 80 lb. rail, of much greater stiffness, its moment of inertia being 26 bi-quadratic inches. The broken lines show the contour of the original section, while the shaded portions show the residual sections. Similar lines for the 6 in. 100 lb. rail indicate the same features.

The comparative oxidized sections were all taken near 86th street, from portions of the rails resting on ties, where the most rapid oxidation occurs under the base of the rails. The oxidation from moisture and from fumes from the locomotives affects the entire exterior of the rails, but to different degrees, being inversely proportional to the rail stiffness.

The axle loads did not greatly increase on the 5 in. 80 lb. rail for four or five years, while the number of wheels passing over the rails increased from year to year. The broad heads were held in position by the wheel treads of the passing locomotives and cars, and did not roll under the wheel treads, as did the 4½ in. 65 lb. sections. The metal in the section was much softer and had not been rolled as cold as the 65 lb. rails, and it should be observed in all these experiments that the rails from



Oxidation and Wear of Rails in Park Avenue Tunnel, New York City.

of the rails had some form of permanent set and the joints were down, and worn.

The opinion of a number of railroad officials at that time was that the rail sections were not sufficiently heavy for the traffic. Everything in regard to the section of the rail was in reference to the weight. Its mechanical element of stiffness was not considered.

The Boston & Albany had at that time in service a 4½ in. 72 lb. rail. After examining all the diagrams, and noting the condition of the rails in the track, the evidence was conclusive that the stiffness of the rail should be increased in a greater ratio for the weight than had been used in the design of the preceding 4½ in. rails, or those of lesser height.

I increased the height of the section from 4½ in. to 5 in., and distributed the metal so as to make the stiffness of the rail a primary instead of a secondary mechanical property. The weight was increased from 65 lbs. to 80 lbs., an increase of 23 per cent. The comparative stiffness of the new 5 in. section and the 4½ in. 65 lb. section, showed an increase of stiffness of over 60 per cent. for the new section, as a simple girder, and about 65 to 75 per cent. for the worn sections in the track.

This large percentage of increase in stiffness of the rail as a girder, would contribute more than its own ratio in the combined stability between the permanent way and the locomotives. If the distribution of the load of the locomotive were limited in effect to a single pair of wheels, then the gain in combined stability between the rails and the locomotive would be in proportion only to the direct increase in stiffness of a rail section. In the construction of the American type of locomotives, the forward truck wheels sub-divide the total load of the locomotive and use the portion on the truck wheels to stiffen the rails as a girder for the driving wheel loads, the combined stability between the two increasing faster than a direct ratio. This feature is not understood generally, and at first was accepted by only a few railroads.

The 5 in. 80 lb. section was under discussion for nearly one year before its adoption; was not rolled until April, 1884, and was laid in the tracks of the Harlem line through the Park Avenue Tunnel, in July, 1884. They replaced the first 65 lb. rails which were laid in the tunnel, after a service of 8½ years. The 5 in. 80 lb. rails, after a service of eight years, were replaced by 6 in. 100 lb. rails. The first 6 in. 100 lb. rails, after a service of eight years, have been replaced by a second set of 6 in. 100 lb. rails. This is the fourth set of rails laid in the tunnel since its construction. The manner of wear, and oxidation, of each section of rails, furnish instructive object lessons as to the action of girders of different stiffness under moving trains.

Fig. 1 shows a section of an original 4½ in. 65 lb. Cammell steel rail, moment of inertia, 16.5 bi-quadratic inches, which had worn and oxidized in the tunnel, after about 8½ years' service. The dotted lines show the original, while the full lines show the oxidized section. The base of many of the rails resting upon the cross-ties had oxidized to sharp knife edges. The section shown by the full lines was found approximately on several rails, where they vibrated and rolled upon the cross-ties. Each wheel load was concentrated rather than distributed upon

which these sections were taken showed more oxidation than any which could be found.

Fig. 4 shows the 6 in. 100 lb. rail after six years' service, in the worst place in the tunnel, the moment of inertia of the section is 48.5 bi-quadratic inches, and approximate tonnage was 80,000,000. The rails remained in service eight years, and the tonnage was 105,000,000. The broad heads of the 80 and 100 lb. rails did not roll under the wheel treads, and the rail seats oxidized much flatter over the cross-ties. The limited amount of wear under the seat of the 100 lb. rail shows that the effects of the wheel loads per tie were much reduced and distributed over a longer space in the track than on the weaker rails.

The loss of metal on the wearing surfaces of the rail heads of each of the sections was about twice as much inside the tunnel as on the outside, for the same tonnage. The passing wheels removed the layer of oxidation which on some days would form in the short time intervals between trains. The small stresses in the web of the 100 lb. rails did not detach the layer of oxidation from the web as rapidly as in the case of the lighter rails.

The value of the increased mechanical element of stiffness in a rail section was demonstrated at once by the service of the 5 in. 80 lb. rails, and was accepted by many railroad officials as an important factor to be considered in the design of rail sections, in order to increase the combined stability between the locomotive, rolling stock and the permanent way. This is due to a more general and better distribution of the total loads of the locomotive and cars on the stiffer rails than is otherwise possible. There is a smaller percentage of each wheel load imposed on each cross-tie. This is shown by the character and extent of the oxidation on the base of the different rail sections.

The 6 in. 100 lb. rail carried, in the eight years of service, double the tonnage of the 4½ in. 65 lb. rails, with one-half of the loss of metal on the base. Tests by the stremmatograph, recording autographically the strains of the distribution of the total load of a locomotive or car in the rail, show this to be true. The illustrations described in my paper in the *Railroad Gazette*, Sept. 8, 1901, showing the limited cutting out of the cross-ties under the 80 and 100 lb. rails, confirm these results. In these oxidized rails this important indication is also corroborated.

The evidence from experience in service is accumulating in demonstration of the theory stated at the time of the installation of the 5 in. stiff 80 lb. rails, that the wheel loads would be distributed over a longer portion of the track, and be of less intensity, for each cross-tie, than was the case with the weaker rails. The demonstration which appeals to the railroad companies is the fact that with an increase of 25 to 40 per cent. more of metal over the 4½ in. rails, an increase of the mechanical element of stiffness of 60 to 80 per cent. is obtained in the rail section as a girder. This has permitted the axle loads to be doubled and the total load of the freight cars to be quadrupled.

The demand for rails as girders, from the steel plants, has required an output of from 2,750,000 to 3,000,000 gross tons per year, exceeding the capacity of the steel

plants in the United States. The general fact is accepted that stiff rails are needed, but in practice the matter is treated in an empirical manner. This arises from the impossibility of calculating the strains in the rails under moving trains, and but little is known of their magnitude or distribution. In service the rail as a girder is tested by its "limits of endurance," and as long as only a small percentage break the axle loads are increased. The usual wheel bases of locomotives distribute the total load of the locomotive, and the effects of the expended tractive effort to a long portion of the track. The maximum intensity of the strain for any inch of the base or head of the rail, under fast trains, is but a small fraction of a second, and is quickly reversed in character. The unit stresses can therefore be higher than would be permissible in bridges, where they last for several seconds. Reference to this feature will be made in connection with the physical properties of the steel for a rail as a girder.

The demonstration of the value of a large mechanical element of stiffness in a rail as a girder, incident to the installation of the 5 in. 80 lb. rail by the New York Central in 1884, marks an epoch in rail design. The head had been broadened, to increase the lateral stability of the rails, and hence of the permanent way. It was intended that the wheel treads, with their loads, would hold the rails in a vertical position, and not allow them to roll as much as with the round topped 4½ in. 65 lb. rails.

The trackmen objected to the increase in the height of the rail, and said that it would be impossible to prevent the rail from rolling out on the cross-ties under the locomotives and trains, and they knew they could not give it sufficient attention on curves to prevent the rails from rolling over and ditching fast trains. This defect, however, has never developed. Ditching fast trains to-day on round headed rails is of frequent occurrence. The rule of thumb, "that the width of the base of a rail must be equal to its height," does not apply to a well designed broad headed rail designed as a girder.

Mr. C. P. Sandberg, in the English edition of the Bulletin of the International Railway Congress, for February, 1903, states: "I have always considered the fastening of flange rails to the sleepers as one of the most important questions in railroad construction. The road made with chairs, as in England, is much more costly than the road made with a flange rail, but it is a necessity in England, with its heavy traffic and high speed. The flange road gives the smoothest run, but the greatest weakness is that the gage does not hold so well as on the chair made road. Two accidents have occurred in France this year owing to this weakness. Even when the weight of rails is increased, the liability of the gage to widen will always be a weak point. Trials have been made with base plates. . . . But whether the flange rail is used with or without base plates, it is the spikes that hold the gage, and the holding power of the spikes depends on the quality of the wood in the sleeper."

The inference in the first sentence is true, though in part for a different reason than that assigned by Mr. Sandberg. And in the last sentence, with the round top rails of Mr. Sandberg's and other Continental engineers' designs, dependence must be put on the spike, or chairs, to hold the rails to gage. But with broad headed, flat topped rails, the weights of the moving wheel loads are made to assist in holding the rails in a normal position for the passage of the train. To hold the rails to the cross-ties firmly without looseness between the rails, spikes and cross-ties, the dog spikes are inadequate, and the unit fiber strains in the rail under the moving locomotives may be increased from 25 to 100 per cent. from this cause.

The sections of the rails must be made heavier and stiffer than would be required with an efficient rail fastening. We meet it partially by stiffer rails for the locomotives and heavy freight cars, but not so well for the passenger coaches. The wheel spacing is so long between the rear and the front wheel of the following truck of the same coach that the rail as a girder is relieved practically of strain in the center of the wheel spacing in distributing the load of the coach. Under the fastest passenger trains the rail is often under tremor from minute roughness of the wheels.

The load of a passenger train is distributed to the permanent way, as a series of general depressions of the rails, cross-ties, ballast and subgrade. Except for the rear coach of the train, each truck of a coach unites with the adjacent truck of a preceding or following coach, to produce a general depression for two trucks, with specific deflections under each wheel contact. The looseness of the rails under the spikes on the cross-ties and the looseness of the latter in the ballast, must be taken up by part of the load, for each general depression, before the loads can be distributed and absorbed by the roadbed.

Where the wheel spacing of the inside wheels of a freight car is 20 ft. or under, the general depression for the load of the train is continuous from the pilot wheel to the rear wheel of the train. The looseness of the superstructure once taken up by the pilot wheel is well retained by the distributed load of the cars, with closer wheel spacing, and the strains in the rails are only from one-third to one-half of those for passenger coaches. This is at least what a number of stremmatograph tests have indicated, and furnish some explanation why it has been possible to increase the freight trainloads in a greater ratio than even for the slow heavy passenger trains. The increased smoothness of the track, on both the 80 lb. and the 100 lb. rails, has permitted a doubling of the weight of the passenger trains, and of more than quadrupling the weight of the freight trains.

On rails having a moment of inertia of 31.5 bi-quadratic inches, the stresses in the base of one rail range from 0.6 to 0.8 lb. per lb. of load, while for a passenger coach it ranges from 1.2 to 1.5 lbs. per lb. of load. The rail as a girder, with a moment of inertia of 28 to 30 bi-quadratic in. permits axle and trainloads of greater intensity than can be sustained by steel bridges designed and built one and two decades ago.

There has been little change in the construction of the roadbed to meet the increase of traffic which has followed the evolution of the rail as a girder. The width of the roadbed remains the same; there is a slight increase in the depth of the ballast, but there has been no increase, practically, in the length of the cross-ties, and only in a few cases an increase in the depth. The number of cross-ties per 30 ft. rail has been increased, in instances where soft woods have been used, to take the place of white oak cross-ties. Railroads which are able to obtain a supply of flatted white oak pole cross-ties have not increased the number under the stiffer rails to as great an extent as those roads which are obliged to use much softer woods.

The increased stiffness, efficiency, and capacity given to the permanent way, comes principally from the increased mechanical element of stiffness of the rail. This has become so generally recognized by the different railroad systems that the lighter rails have not been completely worn out in the track, but are removed and replaced by stiffer sections, for the purpose of increasing the combined stability between the locomotives, rolling stock, and the permanent way.

In metal in the rails which has elastic limits of 40,000 to 45,000 lbs. a unit fiber strain of 30,000 lbs. would stretch each inch of metal at the instant of maximum intensity 0.001 of an inch. A slight increase in this stress would cause a permanent set in the metal of the rails. This was the case with the early rails in the track, permanent sets taking place, so that it was impossible for the trackmen to maintain a smooth surface. The joints did not hold the ends of the rails firmly and thus permitted larger stresses in the base of the light rails than is proportionately the case with the stiffer rails.

In the 5⅛ in. 80 lb. rails stresses as high as 40,000 to 45,000 lbs. are not at all uncommon under high speed trains. These strains can be repeated several times a day for several years without breaking.

In 4½ in. rails made from metal having an elastic limit of 55,000 to 60,000 lbs., unit fiber stresses of 51,000 lbs. have been frequently recorded under six-wheel switching engines, at speeds of 12 to 15 miles an hour. This type of engine is severe on the track and the stresses in the rails are very irregular. They ride unsteady and while all the weight is on the driving wheels the coefficient of adhesion is not as high as in other types.

Rails with 5⅛ in. 80 lb. sections and rolled from low grades of steel, having an elastic limit of 45,000 to 48,000 lbs., have taken sets in the main track, in the past year or two, under the present heavy locomotives running fast trains.

Tracks of the highest standard of smoothness, and which would retain that standard for a series of years under heavy traffic, have all been made of steel which had elastic limits from 55,000 to 60,000 lbs., nearly equal to the ultimate strength of steel used for bridges. The rails were joined with splice bars made from metal having similar physical properties, the length and construction being such as to continue the wave from one rail to the next. To do this in an efficient manner, so the rails will form a continuous girder for the wheel base of the locomotive, or for freight cars, or for the entire train, the splice bars must be capable of transmitting horizontal components of strain from one rail to the next. The rail as a girder cannot efficiently perform its proper functions in distributing the total load of the locomotives or cars to the cross-ties, ballast, and subgrade, unless the continuity of the strains are maintained and transmitted through the joints without addition or loss from one rail to the next. While this is ideal, it is practical, and can and has been secured by simple methods.

Tracks for steam railroads at best are flexible constructions. The track has reached its highest standard of smoothness and perfection when the general depression and specific deflections are so near uniform that the rail acts as a continuous girder, and all of the wheels roll in planes parallel to the surface when unloaded. So much has been accomplished in making the tracks smooth, since the evolution of the rail as a girder, that the undulations per mile on 5⅛ in. 80 lb. rails reduce to 2 ft. 3 in. per mile, and for the 6 in. 100 lb. rails to 1 ft. 6 in. These are slightly less than the calculations made in 1883 for the reduction in undulations for stiff rails. So great has been the effect of such reduction in undulations in the track, in preventing the generation of dynamic shocks under the moving trains that, as before stated, the locomotives, cars, and trains, have more than doubled in weight, and are less destructive to the permanent way than the lighter loads on the low rails.

For electric railroads in city streets, the rail as a girder forms a part of an inflexible superstructure, without a visible general depression and specific deflections under the wheels. The repairs are small for the traffic handled.

The mechanical properties of the section are in a measure distinct from the physical properties of the steel from which the rails are rolled. The physical properties may be utilized to good advantage in the design of the section, but the best results for a rail as a girder will be secured by steel of high physical properties. This matter must be considered when discussing the question of colder rolling of metal for the rails. With the ordinary carbon rails colder rolling reduces the elastic limits, while the structure is refined. Unless the rolling is continued to or below the "critical temperature" the elastic limit is not restored. This leaves initial strains in the metal, which would not be relieved except by a subsequent treatment.

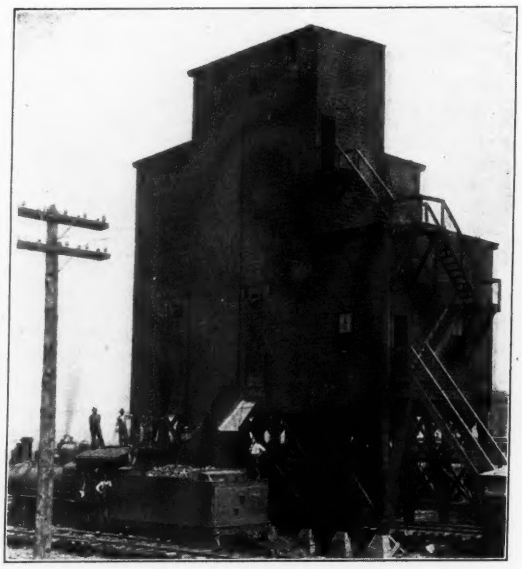
As colder rolling is to become general in the future, a structure should be fixed by composition for higher physical properties, which at the same time can be refined for wear.

The question of the physical properties essential for a girder must be considered for our fast trains for smooth riding, quite as much as for reducing rail wear.

The advantages of nickel steel for rails is that the nickel rapidly raises the elastic limits of the steel and permits a fine structure for wear and also makes a better rail as a girder.

Hocking Valley Coaling Station at Columbus, Ohio.

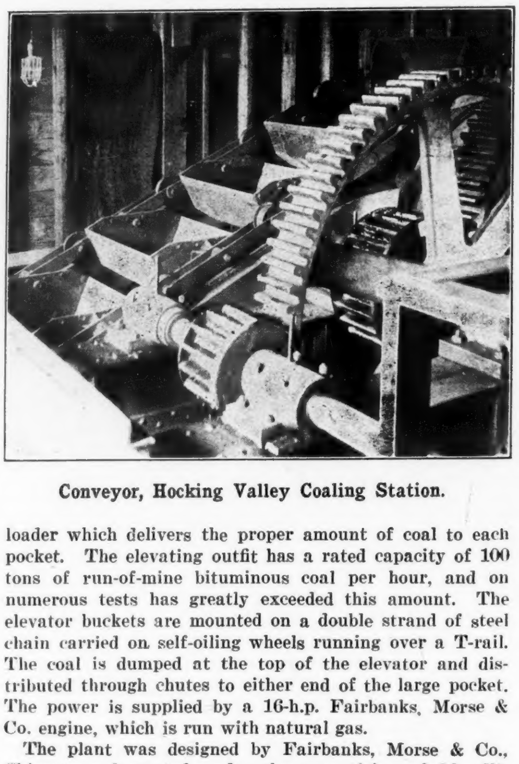
The new coaling station of the Hocking Valley Ry. at Columbus, Ohio, is shown in the accompanying engravings. It consists of one elevated pocket having a capacity of 350 tons. It is arranged to coal locomotives on each side of the structure and the receiving, or unloading, track runs underneath.



Hocking Valley Coaling Station at Columbus, Ohio.

The receiving hopper is 34 ft. long by 17 ft. deep, and it is so designed that coal can be dumped into it from any kind of hopper-bottom or side-dump car, or shoveled from gondola or box cars. This receiving pit will easily hold a carload of coal.

The elevating machinery consists of buckets 30 in. long and 24 in. wide of the pivoted type. The coal is delivered from the receiving pit into the pockets by an automatic



Conveyor, Hocking Valley Coaling Station.

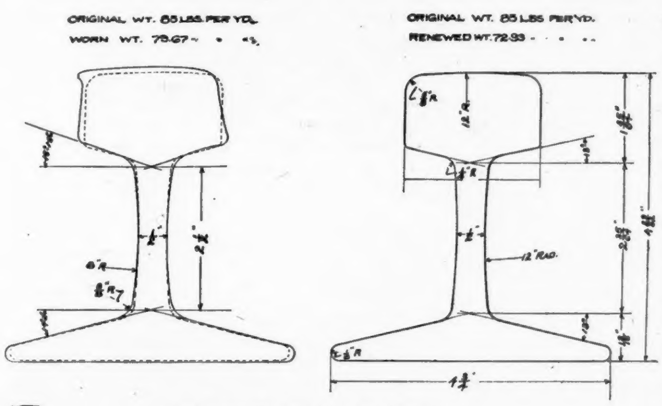
loader which delivers the proper amount of coal to each pocket. The elevating outfit has a rated capacity of 100 tons of run-of-mine bituminous coal per hour, and on numerous tests has greatly exceeded this amount. The elevator buckets are mounted on a double strand of steel chain carried on self-oiling wheels running over a T-rail. The coal is dumped at the top of the elevator and distributed through chutes to either end of the large pocket. The power is supplied by a 16-h.p. Fairbanks, Morse & Co. engine, which is run with natural gas.

The plant was designed by Fairbanks, Morse & Co., Chicago, and erected under the supervision of Mr. W. Michel, Engineer Maintenance of Way of the Hocking Valley.

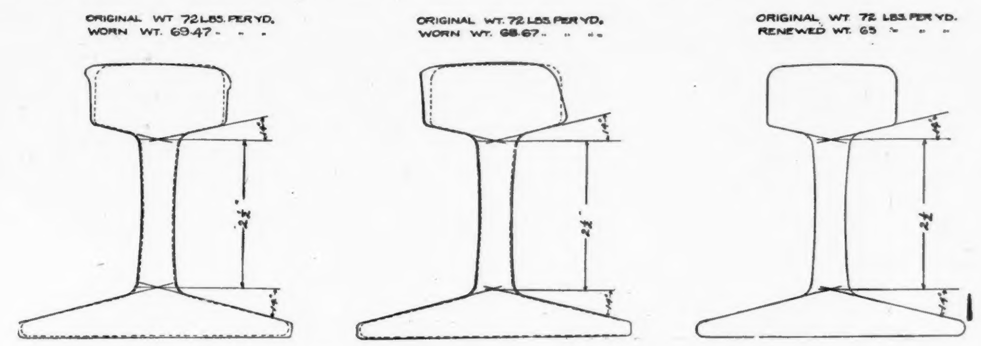
Re-Rolled Rails.

We have already described in considerable detail the McKenna re-rolling process for renewing old rails (Aug. 2 and 16, 1895, and March 14, 1902), and in the latter article one of the three plants of the company was also described—that at Tremley Point, N. J. The other plants are located at Kansas City, Kan., and at Joliet, Ill., and have been in operation for some time. Their combined output up to the present has been something like 200,000 tons. During last year the Joliet mill renewed about 35,000 tons of rails. The tonnage re-rolled by the company annually has increased steadily, as well as the number of roads using the renewed rails.

The Tremley Point, N. J., mill is now nearing completion and it is expected to be in operation in a few weeks. It will have 50 per cent. greater capacity than the Joliet mill, but it is expected that the demands of the eastern roads will fully justify the increase. Its situation on the Central Railroad of New Jersey, near the mouth of the Rahway River, will provide it with ample water transportation facilities. The buildings will have a floor space of about 77,000 sq. ft. and are of structural steel with galvanized steel roofs and sides. Most of the machinery is individual motor driven. The plant will start with one train of rolls, but room for another train is provided.



Rails Re-Rolled by the American, McKenna Process, Chicago, Burlington & Quincy.



Rails Re-Rolled by the American, McKenna Process, Chicago & North Western.

A new feature is a cambering machine for cambering the finished rail on its way to the hot bed.

There are three furnaces of the reverberatory type, each having an average capacity of 20 rails per charge. They are the design of Mr. D. H. Lentz, Superintendent of the company, developed after considerable study and experiment. To heat uniformly a 30-ft. rail was not a simple problem and the success of the process depended upon this being done. The furnaces now in use manage this with entire satisfaction. For re-rolling rails sent in by a railroad company a charge of from $5 to $6 a ton is made, and heretofore the work has been confined to that line only. With its increased capacity the company expects to buy in worn rails, treat them, and then sell them.

It has been maintained for the McKenna process that the re-rolling toughens the rails and makes them more elastic, increasing their durability. An inspection by Robt. W. Hunt & Co. of some new and renewed rails laid on the same division of the Atchison, Topeka & Santa Fe at the same time appears to verify this claim. A point to be noted in connection with the re-rolling of the old rails is that the height of the web is not changed; the old angle bars may therefore be used on the renewed rails.

A New Chicago-St. Louis Line.

When the St. Louis & San Francisco interests bought the Chicago & Eastern Illinois it followed as a logical result that every effort would be made to form a Chicago-St. Louis line. The importance to the "Frisco" people of such a connection was considerably enhanced when control of the Pere Marquette likewise passed to their hands. The plans for this line are now practically complete; in fact, work has already begun on parts of the new road and is expected to have it in operation in good time for the St. Louis Fair.

The accompanying map shows the Chicago & Eastern Illinois lines in Illinois, the proposed line to St. Louis, and the present-existing Chicago-St. Louis lines, of which there are three, the Chicago & Alton, the Illinois Central and the Wabash.

The new line will be built partly by the Chicago & Eastern Illinois and partly by the Cleveland, Cincinnati, Chicago & St. Louis (Big Four). The work being done by the former is under the name of the Eastern Illinois & St. Louis.

Beginning at Woodland on its Chicago-Danville line a cut-off some 62.5 miles long is to be built, running southwest to junction with the Danville-Thebes line at Villa Grove. Then from Findlay a branch 18 miles long is to be built to Pana to connect with the Big Four. The latter will double-track its line from Pana to Hillsboro, for joint use of the two roads, and will build a cut-off from Hillsboro to Mitchell, reducing the distance by 12 miles. This will give the new line a total of approximately 290 miles, against 283.8 for the Alton, 286 for the Wabash, and 292.96 for the Illinois Central.

On the Woodland-Villa Grove cut-off topographical conditions are such that very nearly an air line was possible, and the survey has approximated as closely to this as was practicable. It will be noted that, though passing quite close to several towns, they were disregarded, directness of route being the primary consideration. At this writing, however, influence is being brought to bear to have the line diverted to Rankin, and it may possibly prevail.

Including the Cissna Park branch of the C. & E. I., five roads will be crossed, being, in order, after the branch mentioned, the Lake Erie & Western, the Illinois Central (Rantoul branch), the Big Four (Peoria division), and the Wabash. The Lake Erie & Western and the Illinois Central are to be crossed overhead. How the others will be crossed has not yet been fully settled, but it is probable that the Eastern Illinois & St. Louis will go under the Wabash, and will cross the Big Four at grade.

Double-tracking the Big Four between Pana and Hillsboro involves the building of some 27 miles of second track. The Hillsboro-Mitchell cut-off will leave the present line a little to the northeast of Hillsboro and deflect southward from the direct line in order to make the crossing of the Middle and West Forks of Shoal Creek with but one grade each way. The plan is to cross all intervening railroads either above or below present grade, except the Jacksonville & St. Louis, which is so located that a grade crossing will be necessary.

The ruling gradients will be 26 ft. per mile southbound and 21 ft. northbound for the Chicago & Eastern Illinois, and 26.4 ft. each way for the Big Four. The maximum curvature for the new sections will not exceed 1 deg. on the Eastern Illinois & St. Louis, and 1 deg. 15 min. on the Big Four. However, there will be on the entire line one curve of 3 deg., this being on the present line of the Chicago & Eastern Illinois; there are also some 2 deg. 30 min. curves.

On the Eastern Illinois & St. Louis the line will be graded, and all permanent structures are designed for double-track, although the second track will not be laid right away. It is expected to get to this within another year perhaps. The line will be laid with 80-lb. rails, it not being deemed advisable to lay new work with anything heavier than this. However, the recently-adopted standard for repairs for the C. & E. I. is 85 lbs., and this weight will eventually be substituted, as conditions make necessary.

Gravel ballast will be used throughout the Eastern Illinois & St. Louis. The C. & E. I. owns a large gravel pit on the Wabash River where it crosses in Indiana, from which large quantities of ballast are obtained. All bridge abutments and piers, and all large culverts will be built of concrete.

On the Woodland-Villa Grove line it has already been mentioned that none of the crossings would be at grade except possibly the Big Four, which latter is still unsettled. Should a grade crossing be agreed upon, an interlocking plant will doubtless be put in. Between Villa Grove and Pana there are three grade crossings, one of which Tuscola, is already interlocked. Arrangements are about completed for a plant at Arthur, and Sullivan will probably be arranged for in the near future.

The Eastern Illinois operates its trains by the telegraph block system, and this will doubtless be continued. Positive blocking is the practice for passenger trains, permissive blocking being allowed for freight trains.

The Big Four will also lay its new line with 80-lb. rails, and will ballast with chatts. On the line between Pana and Hillsboro there are a number of small stone arches to provide for existing waterways and cattle passes, the largest of which is 20 ft. in diameter. These will, of course, be extended for the second track. On the cut-off the bridges and culverts will be of concrete arch masonry in most cases, there being but two streams of importance to be crossed. There will be steel bridges at the crossings of the intervening railroads, but the details for these have not yet been decided upon. The grade crossing with the Jacksonville & St. Louis will be protected by an interlocking plant.

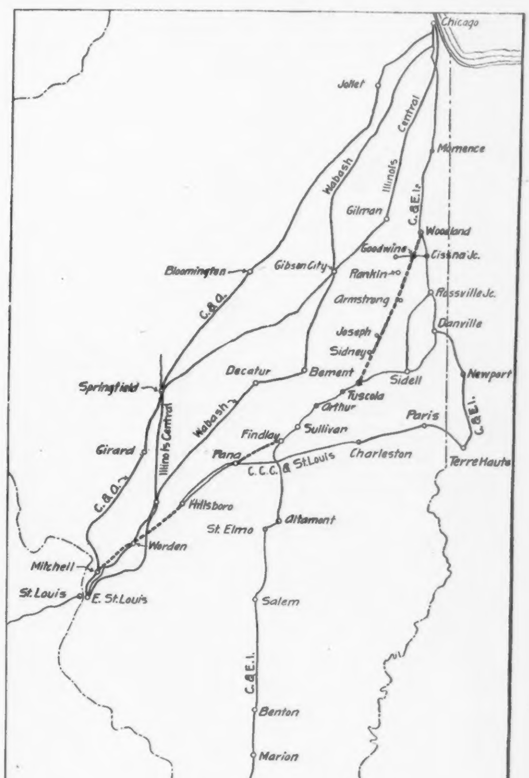
The steel bridges for the Eastern Illinois & St. Louis have been proportioned for a live load of two 177½-ton consolidation engines, followed by a uniform trainload of 5,000 lbs. per lineal fot of track, being "Cooper's Class E-50" loading. The unit stresses adopted were 16,000 lbs. per sq. in. for tension, and the same stress reduced by a column formula for compression. The live-load stresses were increased by the impact formula of $\frac{300}{300 + \text{length of load.}}$ The fixed wind load has been taken at 30 lbs. per sq. ft. and the moving wind load at 300 lbs. per lineal foot; or for the unloaded structure, a wind load of 50 lbs. per sq. ft. of exposed surface of structure.

The specifications for material require open-hearth steel, with a maximum phosphorus of .04 per cent. for basic, or .08 per cent. for acid steel; and a tensile strength of 62,000 per sq. in., with an elongation of 25 per cent. in 8 in. This steel must stand bending cold 180 deg. flat. A variation of 4,000 lbs. above or below the desired tensile strength is permitted.

The specifications for shop work require the planing of sheared edges, and the reaming of punched holes, except for lateral connections and minor details. In reamed work, the diameter of the punch must be at least $^3/_{16}$ in.; and the diameter of the die at least ⅛ in., less than the diameter of the rivet; or for most of the work the holes will be punched $^{11}/_{16}$ in. and reamed to $^{15}/_{16}$ in. diameter. The flanges of I-beams used in the floors of the bridges will have all connection holes drilled from the solid.

The specifications for painting call for the work to be oiled in the shop, except that all parts not accessible for painting after the erection, including tops of stringers, ends of posts, and chords shall have a good coat of approved paint before leaving the shop.

All of the deck plate girder spans have been designed so as to avoid the use of cover plates and give a smooth, uniform surface to the top flanges for the ties to rest upon. The flange sections for the 60 and 65-ft. girder spans are shown in the general plan of the double-track trestle over the Middle Fork of the Big Vermillion River and the Illinois Central R. R., presented herewith. Stiff bracing has been used for laterals and tower bracing.



Chicago-St. Louis Lines, Present and Proposed.

The trestle mentioned consists of five 60-ft. spans, one 65-ft. span, and five 30-ft. tower spans. The girders for these spans have a uniform depth of 6 ft. back to back of flange angles. The 30-ft. girders are rigidly connected to the towers. There is one fixed end, and one expansion end on each tower for the 60 and 65-ft. spans. The towers are 23 ft. 2 in. high from top of masonry to

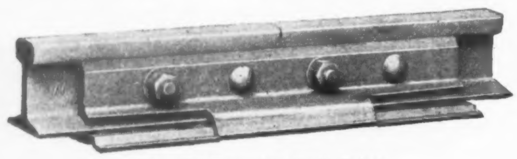
base of girders, or 30 ft. from top of masonry to base of rail. These towers being comparatively low, it was unnecessary to give the posts any batter. Each bent consists of one cross girder, 6 ft. deep, and two plumb posts made up of one 15 in. 50-lb. I-beam and two 15 in. 40-lb. channels. The tracks are 14 ft. center to center, and the girders for each track are 7 ft. center to center.

Where the fixed ends of the 60-ft. spans join the 30-ft. tower spans, single-end cross frames are used. At the expansion ends separate cross frames are provided for the 30-ft. and 60-ft. spans.

In addition to this trestle there will be a number of deck-girder spans, from 30 ft. to 80 ft. long, and one 54-ft. through plate-girder skew span, having a shallow floor, where the road crosses the Lake Erie & Western. All of the bridges have been designed under the direction of Mr. W. S. Dawley, Chief Engineer, by Mr. T. L. Condron, M. A., Soc. C. E., Consulting Engineer. The contract for the steel work has been let to the American Bridge Co. The structures will be made at the Detroit plant of that company and erected by the railroad company.

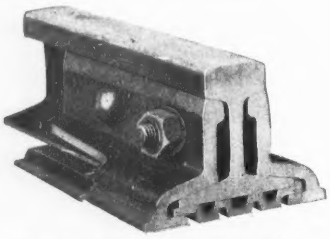
Tie-Plates and Rail-Joints.

Mr. Wolhaupter has improved his tie-plate (shown in the *Railroad Gazette*, Jan. 23, 1903, p. 65) by changing the form of top, which is now made to slope toward the sides from the center. This is to increase its ability to shed foreign matter, and particularly liquids that may



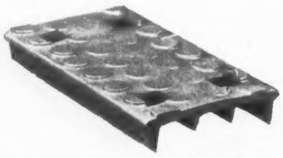
The Wolhaupter Rail-Joint.

drop upon it, such as brine from passing refrigerator cars. The rail seat has not been changed, the tops of the bosses being on a level across the plate. He has also developed the rail-joint shown by the illustration.



Section, Wolhaupter Rail-Joint.

The joint is composed of a corrugated base-plate extending under the rail ends for the full length of the joint, and two angle-bars having the flanges formed to clamp the base-plate and hold it firmly against the base of the



Improved Chicago Tie-Plate.

rail. By this means the bearing surface of the joint on the rail and ties is increased.

The corrugations of the base-plate are to give additional strength; also the plate has on its outer edge a shoulder against which the outer rail-flange abuts. As the inside spikes pass through the holes in the base-plate the track alignment is established and is not affected by adjustment of the bolts, while the amount of spike area available for resisting lateral thrust is almost doubled. It is considered that this feature should prove especially valuable on curves.

The upper part of the angle-bars does not differ in design from usual practice, having bearings under the rail head and on top of the rail flange; but the form of the angle-bar flange gives greater depth and therefore greater stiffness. The inside angle-bar is interlocked with the base-plate, concentrating the metal under the rail ends.

The joints are being rolled by the Illinois Steel Company. Like the tie-plate, they are controlled and sold by the Independent Railroad Supply Co., Chicago, of which Mr. Wolhaupter is Manager.

The conviction that the country is going ahead too fast is at the root of much of the serious opposition with which the Japanese Government is now meeting. The Kure dock-yard, for example, is on a scale fitted for the building of line-of-battle ships, and yet there is absolutely no chance of its getting any but very small vessels for a long time to come. The great iron foundry in Wakamatsu, also, which has already cost the Government 20,000,000 *yen* ($10,000,000) and is sure to cost more, is a dismal failure and is consequently about to be sold to private capitalists. There is also a reaction against the present craze for building enormous fortifications along the seacoast and fitting them with costly pieces of artillery. It is recognized that this money had very much better be spent on ships.

Scherzer Rolling Lift Bridges.

Some of the more interesting undertakings of the Scherzer Rolling Lift Bridge Company, of Chicago, are as follows: A railroad and highway bridge across the Swale River near London, England, for the South-Eastern & Chatham Railway, Sir Benjamin Baker being the consulting engineer in charge for the railroad company. The new Scherzer bridge replaces a trunnion bascule bridge and is being built without interfering with or diverting either the railroad or highway traffic; also maintaining the necessary clearances under the bridge required by the British Admiralty.

Two double-track railroad bridges across Newark Bay for the Central Railroad of New Jersey, Mr. Joseph O. Osgood, Chief Engineer. These two bridges are placed back to back. The base of rail is only 4½ ft. above high water, but the bridges are so designed that all structural parts are kept above high water at all times. Railroad traffic and navigation are both maintained during the construction of the bridge without diverting the railroad tracks. It is the intention of the railroad company ultimately to carry two additional tracks across Newark Bay, and the bridges were designed with a view to adding two similar double-track bridges along the existing structures later on. The span of each of these bridges is 120 ft.

A double-track railroad bridge across Crystal Cove, Mass., for the Boston, Revere Beach & Lynn Railroad, Mr. G. M. Thompson, Chief Engineer. This bridge is a plate girder structure and is designed to carry heavy engine loadings, the tracks being standard gage. The substructure is composed of timber resting on piles.

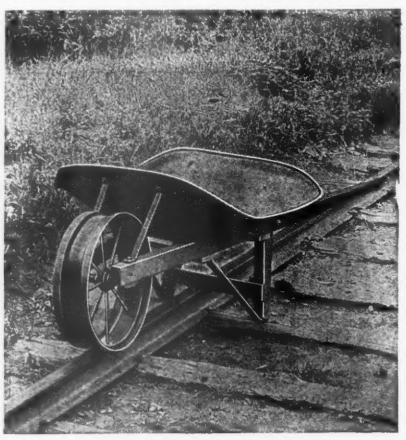
The four-track bridge across the Pequonnock River at Bridgeport, Conn., for the New York, New Haven & Hartford, Mr. C. M. Ingersoll, Jr., Chief Engineer, is rapidly nearing completion. This bridge is composed of two double-track bridges placed side by side, to be operated either jointly or separately, as desired. They are deck plate-girder structures.

The double-track, 275 ft. span Scherzer bridge across the Chicago River at the entrance to the Grand Central Station, is giving very satisfactory service. The base of rail of this bridge is very close to the water so that the bridge is opened very frequently for the passage of tugs and other small craft, yet it is considered that much time is saved to railroad traffic because with this type of bridge a partial opening is sufficient for small vessels. The bridge has shown itself to be extremely rigid under the heaviest loadings; this may probably be accounted for by the absence of the end lifts and rail lifts required by swing bridges. The counterweight also adds to the rigidity of the structure.

The railroad bridges of the Scherzer type in operation for a number of years at Cleveland, Ohio, and other points are giving successful and satisfactory service.

The American Trackbarrow.

The accompanying cut shows a somewhat new type of trackbarrow, used for running earth, ballast and other materials short distances on the rail. The patent covers the wheel and its application to a barrow. The wheel is 17½ in. diameter and weighs 16 lbs.; the tire is steel,



five in. wide. The cut shows the wheel fitted with an axle which revolves in a U-shaped box attached to the under side of the frame; it has been decided to change this form of construction and allow the wheel to revolve on an axle run through the center of the frame and fastened on both sides by nuts. The novel feature is the angle at which the wheel is set in the frame, allowing the user to walk alongside instead of astride the rail. It is claimed that because of its usefulness on and off the track and the ease with which it can be handled, the barrow is for some work more serviceable than a push car. The maker is The American Trackbarrow, Lowell, Mass.

Goodwin Cars at Work.

The illustrations show the methods of using Goodwin cars in handling different materials about furnace yards.

Fig. 2 shows a train of Goodwin cars loading at the mine with bituminous coal. Fig. 8 shows the handling of this coal into the chutes at the loading dock. The train is pushed on to the dock and is unloaded by two men in less than ten minutes, the cars being unloaded one at a time into a single chute and the train pulled off from the trestle without having uncoupled either the cars or the locomotive.

Fig. 5 shows a train of Goodwin cars being unloaded, one compartment at a time, into a plate mill boiler house coal pocket. In this case the coal is pulverized and is discharged through the restricted opening. This is the same train shown in Fig. 2, and after discharging its load of coal from the dock it was run under the ballasting crusher and loaded, as shown in Fig. 18; proceeding on its way for another load of coal and at the same time distributing the ballast as the train passed over the road, running at the rate of about four miles per hour, and placing the ballast as required, either at one side of the track or the other or between the rails. The operation of discharging broken stone at one side of the track while running, is shown in Fig. 1. The entire train may be discharged from any car in the train or from the roof of the instruction caboose by using the air dumping pressure, opening the air valve by the use of the air-dumping lever. Fig. 9 shows the operator on the roof of the caboose with the air dumping valve in his hand, ready to discharge the entire train.

Fig. 14 shows a train of Goodwin cars being loaded with coke at the ovens. The instantaneous discharge of coke from the car and the large percentage in the saving of the breakage are the main features of advantage in the handling of this material. Where coke is handled exclusively the cars are fitted with coke racks.

Fig. 12 is a view looking down into the train of Goodwin cars loaded with pig iron; about 140,000 lbs. of pig iron in each car.

Fig. 13 is an instantaneous view of a load of pig iron being discharged, the photograph being taken before the load of pig iron reaches the ground, as it is sliding from the side discharge aprons clear of the trestle.

Fig. 11 is a view from the top of the pig iron trestle and shows the pig iron on the ground as discharged from the same train, shown in Fig. 13. This entire load of pig iron was discharged one car at a time in less than 15 minutes, by two men. There is very little shock received by the trestle or the car in discharging this enormously heavy load. This is explained by the construction of the car, which allows the load to start in its outward movement from its most centrally located position in the car without any shock or jar; this method instantly lowers the center of gravity without producing tipping or careening tendency. The fact that the pig iron is thrown clear of the footings of the trestle as shown in Fig. 11 is an advantage where light trestles are in use. Pig iron, as it is generally cast to-day in molds secured to continuous linked belts, is conveniently handled where the Goodwin car is used as the pigs may be dropped from the molds directly into the cars and the V-shaped section of the floor of the car renders the stacking and handling of the pig iron unnecessary. Since each piece finds its own location and although the pigs are hot when tipped into the car there is no buckling, binding or interference with the discharge of the load through the heating of the car. Comparing these methods of unloading with the usual method as shown in Fig. 22 the amount of time and labor saved in the operation will be appreciated.

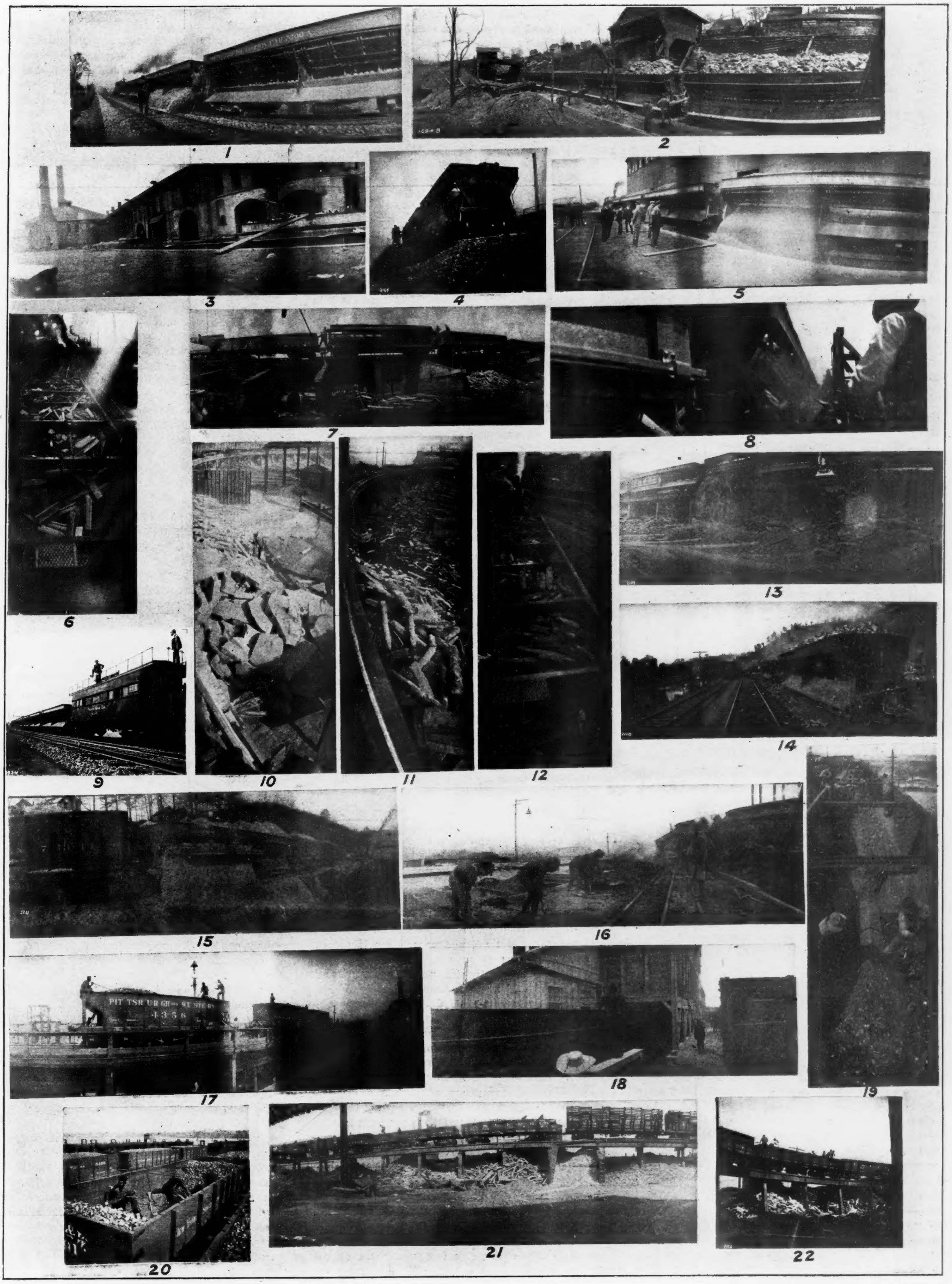
Fig. 3 shows the rail end loading pit at the rail mill. There are two Goodwin cars located in the pit, one at each of the arched openings opposite the two rail saws. These saws cut off the ragged ends of the red hot rails. The ends vary from one to four feet in length and immediately upon being sawed from the rail they are thrown into the cars. A hose secured to the side of the building plays into the car while loading. Fig. 6 shows a load of hot rail ends in a Goodwin car on their way to the converter bin. In Fig. 7 this same car is shown in the act of discharging the rail ends into the converter bin; the operator using the hand power discharging apparatus.

Fig. 21 shows a train of ordinary gondola cars loaded with rail ends which are being thrown from the cars, one piece at a time, with about eight men in each car. This is the old method employed for unloading rail ends about furnace yards. In comparing the two methods of handling, it will readily be seen that there is much time and labor saved by the more modern method. Where it is necessary to throw the rail ends from the car by hand, one piece at a time, they have to be cooled sufficiently to allow a man to pick them up. This cooling is unnecessary where the Goodwin car is used.

Fig. 10 shows a load of 95,000 lbs. of mold scrap discharged out of a Goodwin car from the converter trestle, each piece weighing from a pound to 5,000 lbs. One man unloaded this 95,000 lbs. of mold scrap in less than two minutes time. Ordinarily, this material is pried off from flat bottom cars with crowbars, eight to ten men working on a car, taking several hours to unload each car.

In Fig. 16 can be seen the top of a train of Goodwin cars located in the converter cinder pit; red hot converter cinder is being loaded. Fig. 4 shows a train of cars filling in an embankment with converter cinder, the cinder being hot when it is discharged from the cars. Fig. 15 shows a car discharging granulated mill cinder for widening roadbeds, the granulated cinder being mixed with water, being loaded hot into the cars. A carload of this cinder clears a car in a few seconds and can be placed on either side of the tracks or between the rails while the train is standing or running, either on level ground or from a trestle.

In order to compare the methods of unloading coal from the Goodwin car with the usual method of unloading from the hopper car, attention is called to Figs. 17 and 19, showing eight men at work, and to Fig. 20, showing four men at work.



Goodwin Cars at Work.

RAILROAD GAZETTE

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EDITORIAL ANNOUNCEMENTS.

CONTRIBUTIONS.—Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies in their management, particulars as to the business of the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and railroads, and suggestions as to its improvement. Discussion of subjects pertaining to ALL DEPARTMENTS *of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.*

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The office of the Railroad Gazette is now at 83 FULTON STREET, at the corner of Gold Street, east of Broadway.

Herbert Spencer, guide, philosopher, and friend of our race, but especially a philosopher, penned and printed more than forty-three years ago, an essay on "What Knowledge is of Most Worth." In this he emphasizes the value of a proper degree of scientific knowledge to investors. He tells us in his essay of men who have lost their fortunes in coal mine investments, "from not knowing that a certain fossil belonged to the old red sandstone, below which no coal is found," and proceeding in the same strain launches this statement:

> "Numerous attempts have been made to construct electro-magnetic engines, in the hope of superseding steam; but had those who supplied the money understood the general law of the correlation and equivalence of forces, they might have had better balances at their bankers'. Daily are men induced to aid in carrying out inventions which a mere tyro in science could show to be futile."

With electric power superseding steam in a hundred directions in manufacturing and in transportation—including the English railroads—one smiles at the thought where electric science itself would have passed, had it accepted the great British philosopher's dictum. At least may he be accounted happy that, now jostling his eighty-third birthday, he has been spared to revise his opinion.

The valuable series of timber tests which were begun by the Forestry Division of the U. S. Department of Agriculture, but unfortunately abandoned as the result of a change of administration in the Department, are now being renewed by the New York State College of Forestry (at Cornell University), the Director of which college is Dr. B. E. Fernow, who was for several years Chief of the U. S. Forestry Division. In another column we give a report of a set of tests which were made at the College under the direction of Prof. F. Roth, in connection with his course on Timber Physics, as a continuation of the valuable series of tests designed and carried on by Dr. Fernow, when Chief of the Division of Forestry. These tests are of more than usual significance, being, it appears, a practical demonstration of the fact that not only is there a true elastic limit in wood, but that the strength of a wooden beam at the elastic limit is equal to the compression strength of the material. This law, deduced from the long series of government tests above referred to, and mathematically and theoretically proved by Mr. C. E. Neely, is now given a practical proof by this series of tests, instituted for the purpose. The value of this law is apparent. Since in practice the strength of a beam at the elastic limit, rather than the breaking strength, is of importance, a knowledge of that strength is desirable and this knowledge can readily be secured by a simple compression test. It has long been recognized that in wood testing the compression endwise gives the most satisfactory results, while the use of wood as a beam is the more frequent. The beam test, however, is unsatisfactory, being a compound of compression and tension. By the discovery of the relationship between compression strength and cross bending strength the means are given to determine easily, quickly and with considerable precision the strength of wood in cross bending, or that portion of it which is of practical value.

With this issue of the *Railroad Gazette* appears the annual Construction Supplement of new railroad and bridge work in the United States, Canada and Mexico. This Supplement contains, as heretofore, a list of new railroads, as well as a list of the extensions and improvements projected or building by old roads. So far as is possible, in the case of new projects recorded, the names and addresses of the incorporators are given, and when contracts have been let, the names of the contractors are generally stated. The Supplement also contains a list of railroad, county and city bridges, where contracts (so far as is known) have not as yet been let. No attempt is made, however, to mention all the bridges required by new railroads, as this is practically covered in the Construction columns. The information in this Supplement is not merely a summary of the news which has appeared from time to time in our columns, but is acquired in great part from correspondence with railroad officers and from other official sources now for the first time made public. Great care has been taken to make the report as complete and accurate as possible, and to note the exact status of each line at the present time. The Supplement, this year, shows an increase over last year of nearly 25 per cent. in the number of lines building or under contract, and the total number of projects is greater than ever previously reported.

The suggestion which Dr. Dudley makes in another column respecting the material from which rails should be rolled is of considerable interest. He says that the cold rolling of carbon rails reduces the elastic limit unless rolling is continued below the "critical temperature." Inasmuch as a high elastic limit is desirable for rail steel the future composition should be fixed by experiment to give high physical properties and be of such a character that it can be refined for wear. Any design of rail section which fails to give mechanical stiffness its proper place will be of lessened value. An increase of 25 to 40 per cent. in the weight of the old 4½ in. 65 lb. rail has resulted in an increase in the stiffness of from 60 to 80 per cent., which increase has permitted axle loads to be doubled and total loads of freight cars to be quadrupled. The function of a well designed rail is not to absorb the concentrated load from each wheel but the stiffness should be such as to transform the entire length of the rail underneath the locomotive and cars into a continuous girder. This calls for splice bars of high tensile strength so that the stresses can be transmitted without loss or increase from one rail to another. Under such conditions the forward truck of the locomotive takes up the slack (presses the ties down to a hard bearing) in the roadbed and relieves the following wheels from the shock which would otherwise develop in their passage over each rail. Stremmatograph tests have shown that the unit stresses beneath a six-wheel switch engine are often 51,000 lbs. per sq. in., while the elastic limit of the material is only from 55,000 to 60,000 lbs. That such high stresses can be used without serious results is due to the fact that their duration is but a fraction of a second and are soon reversed in direction. Other things being equal, the rail having the greatest moment of inertia for the least weight of material will be the most efficient. It has been shown by experiment that the oxidation of the stiff rails is less than that of the older and weaker designs. This is due to the fact that the initial oxidation remains on the stiff rail for a longer time and is not shaken off by the passage of each train, thus protecting the interior. Nickel steel has of late been given considerable attention, as its properties appear to be ideal for the manufacture of rails; the elastic limit is high, thus increasing the stiffness and the structure is of sufficient refinement to insure good wearing qualities.

Dealing with Strikes.

It is probably true that whenever a railroad officer is forced to deal with a trade union threatening a strike, he has no fixed principles of business that he dares adhere to; he gropes in the dark. If he is conscious of having treated his co-employees fairly and well, he is bursting with indignation which he must not express. His sub-consciousness is that this National Organization with whom he is negotiating for the privilege of continuing uninterrupted traffic on his road is, or is trying to be, a tyrannic monopoly, a leveller of all the working members of its union. Its only hope of success lies in preventing a good workman from getting more pay than a poor one, in preventing, if possible, any chance for any one man to show his competence and get on. The railroad officer may have in mind his own struggle up from the ranks from which he rose "by the sheer buoyancy of his genius," and feel a scorn he cannot utter for these repressers of individualism. He is restrained from dismissing the Committee of the National Organization with words to the effect that he is a trustee and that it would be a violation of his trusteeship to delegate that trust; that he must confer and agree with his employees only and not abandon that responsibility to outsiders.

He is not so restrained by fear of any harmful results to his company lawfully brought about, he is simply afraid of anarchy, of the unlawful destruction of property, of brutal beatings, dynamite and murder, of that "persuasion" which is formally authorized by the unions and which was lately described as, "besetting and the like." The alternative is to yield sweetly and to attempt the impossible—to ride without control.

> "There was a young lady of Niger
> Who smiled as she rode on a Tiger;
> They came back from the ride
> With the lady inside,
> And the Smile on the face of the Tiger."

The Tiger in this relation is not the workingmen; it is the elusive, irresponsible organization of their tyrants. Each man of them is limited not alone in his hours of work, but in the quality of his work to something like the average of the shiftless, and the company is by so far hindered from discovering ability and loyalty and recruiting from the ranks for positions of authority.

All this is homily, but it is possibly now timely to repeat the platitudes, for there is a growing disposition to discover whether existing law is applicable and enforceable. Aside from the statutes relating to conspiracy, the act of July, 1890, to protect trade and commerce, seems to be applicable. Its first sentence is: "Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of commerce among the several States, or with foreign nations, is hereby declared to be illegal." Every word of this sentence seems to be definitive of the organization and operation of a railroad trade union.

In this column last week was given some account of Judge Adams' order restraining the trainmen's and firemen's brotherhoods from abetting a threatened strike on the Wabash. In moving for the dissolution of this injunction the attorney for the brotherhoods filed a series of denials which are significant. He denies:

That the brotherhoods "have unlawfully or maliciously conspired, or confederated together to force the complainant to recognize" the brotherhoods.

That any demand has been made upon the Wabash "to employ exclusively in its service such persons as are members of said" brotherhoods.

That they "represented to certain of the Wabash employees that they would get an increase of wages for them."

"That they ever maliciously threatened to order a strike."

The injunction and these denials are significant because they seem to show a way out. No railroad officer of experience doubts for a moment the truth of the allegations and the substantial untruth of the denials. No strike of modern times has failed to involve what is here solemnly denied, and if this is the issue possibly the result may be hopeful.

It is not at all strange that this attempt to enforce the law seems novel, and perhaps is novel here. In England the Taff Vale Railway Company has recently recovered heavy damages from the trade union and its officers for conspiracy in supporting a strike, but we have become too accustomed to the "Jury of public opinion"; we seem to have forgotten the law, and to have become accustomed to a barbaric joust by means of which the attention of the public is invited to the question at issue. Amid riot and recrimination the truth leaks slowly out and the public decides that members of the union shall or shall not have an additional ten cents a day; shall or shall not di-

minish their individual productiveness; and that "scabs" may or may not have a chance to earn a living.

Perhaps conspiracies in restraint of trade, in restraint of liberty and of individual development, may be repressed by law. Perhaps an increasing number of broad-minded officers will so watch and care for the interests of their men as to make them feel that loyalty is the best policy; that permanency and promotion for merit are assured to the humblest workman, and that in all cases where it is possible the organization of the corporation is to be built up from the inside. We believe it will be so.

Railroad Shops.

The railroad shop, while embodying engineering features in its design, should nevertheless be made with an eye single to its value for the operating department. The advantages of one shop system over another, and within limits, the greater or less first cost, should not be considered. In other words, the shop is simply a tool for the operating department, for handling the equipment quickly and economically and restoring the earning capacity of tied up capital in the form of locomotives and cars.

The modern tendency is to centralize all heavy repairs in one or more large shops, and it is quite generally acknowledged that the failure to do this is decidedly uneconomical. Conditions which exist at the present time are different from those which held ten years ago. A passenger locomotive at that time having 75,000 lbs. on the drivers and 1,300 sq. ft. of heating surface was considered large, while to-day locomotives in similar service have 145,000 lbs. on drivers, and over 4,000 sq. ft. of heating surface. The increase in the size and capacity of cars has been proportionately great, and the advent of the steel car has made necessary the introduction of special tools and facilities for their repair. Railroad shops which were considered up-to-date even five years ago are now severely hampered in the handling of new and heavy equipment. Owing to the recent advances made in tool steel and the more rigid construction of machine tools specially adapted for using these improved steels at high cutting speeds, it has been possible to greatly decrease the cost of machine work. It should be remembered, however, that these advances in shop methods have only kept pace with the increase in the size of the parts to be handled. That is to say, it requires approximately about the same time to turn out a modern driving axle, 10 inches in diameter by improved methods, that it did ten years ago to turn out a six or seven inch axle with the old tools and equipment. The cost and speed of removing one pound of metal is now much less, but a greater number of pounds must be removed from the same part than was hitherto necessary.

The proper design of a railroad shop presents many problems of great complexity and the lack of available data on the subject has been the cause of some serious errors in certain modern designs with which we are familiar. The proper balancing of the several departments in a large shop and the organization of the work must all be anticipated in the initial design. Proper allowance for future increase in facilities must also be carefully considered and enough land should be owned at the start before adjoining improvements enhance its value. A delicate matter for consideration is the determination of the traffic center for the division or road as the case may be, so that the equipment will be returned to service when it is most needed. Whether to use the direct or alternating current and the grouping of the machines for driving are also open questions at this time. Modern examples of both systems are to be found and considerable merit is shown for the alternating current polyphase system which gives a simple and efficient speed control.

The modern heavy equipment has only recently begun to be shopped, and the inadequacy of the present facilities is becoming more and more apparent. The next few years, it is safe to say, will see a general rebuilding of old and antiquated shops, and data such as has been collected by Mr. Berg will simplify many, of the otherwise, complex problems.

We begin in this issue his series of articles on railroad shops. The author has covered the ground in a careful and comprehensive manner and has discussed the shop question from the broader aspect of its relation to the other departments. From the nature of the subject, it becomes necessary to carefully review the predominating features in old and new shops as much of the data of value to the designer can only be obtained from the result of experience. The ratios which have finally been deduced will be of inestimable value, for we do not know of any similar work.

Delaware, Lackawanna & Western.

The report for the year ending Dec. 31, 1902, shows gross earnings of $21,398,764; a decrease of $2,108,870 from 1901, which is doubtless fully accounted for by the losses occasioned by the coal strike. Total expenses were $13,641,052, leaving net earnings of $6,921,341; a decrease of $2,200,875. But, in spite of the diminished earnings, $3,383,504 was charged to maintenance of way and structures; which is at the rate of $3,569 per mile of road. For maintenance of equipment, $2,712,595 was spent; an increase of $258,358 over the amount used in 1901, and the policy of paying a 7 per cent. dividend was continued, with the result that a total deficit of $2,180,652 was carried forward to profit and loss, as against a surplus of $1,196,055, last year. Earnings from transportation of miscellaneous freight, however, increased $344,735, and earnings from passenger, mail, express, and milk traffic increased $154,280, in spite of the fact that the passenger earnings in 1901 were abnormally large, on account of the Pan-American Exposition. The management attributes the gains to its policy of encouraging the location of industries along its lines, with trackage and facilities for handling freight, and also to the increased efficiency of the system, owing to the extensive betterments and to the new equipment. It is thought that the rebuilding of bridges and masonry, which has been the chief occasion of the heavy maintenance charge, will be practically completed by the close of 1903, and that what remains to be done can be extended over a series of years, so that the annual expenditure will be greatly lessened. But increased wages for employees, and the prevalent high prices for fuel and supplies are expected to make a considerable increase, during the coming year, in the cost of conducting transportation.

Statistics of operation follow:

	1902.		
Passenger train miles	5,119,262	Dec.	161,139
Passengers carried	16,228,335	Inc.	1,202,339
Passenger miles	316,642,899	Dec.	3,993,114
Freight train miles	5,047,850	Dec.	1,203,389
Tons moved	6,644,069	Inc.	83,416
Ton-miles	1,000,131,897	Inc.	23,892,046
Av. freight train load (tons)	360.75	Dec.	11.63

The Taff Vale strike settlement, with which the reader is familiar from former reports (see Jan. 9, p. 33), involves the tidy sum of $115,000. It will be recalled that in the findings of Mr. Justice Wills and a London jury against the defendants (the Amalgamated Society of Railway Servants, et al.), the amount of damages to be awarded for the injuries sustained by the railroad company, was not settled, but was left for assessment by the judge, at the next sitting of the court. On Feb. 11, however, the A. S. R. S. settled out of court, by compromising for £23,000, including costs, although a sum slightly in excess of this amount would have been asked from the court. The strike, which was the occasion of the litigation, occurred in August, 1900, and the specific wrong for which remedy was sought was the breach of contract of which the strikers made themselves guilty by their failure to give 14 days' notice before ceasing work. The railroad company, at the outset, obtained an injunction against picketing, and this was carried from court to court, until finally affirmed by the House of Lords, which also decided that the Amalgamated Society could be sued. If the precedent become widespread, that labor unions cannot by complexity of organization shift away the responsibility that would attach to an individual, and that they have something to lose by a strike, instead of everything to gain, the results of the Taff Vale decision may become of great importance. The *Engineer*, of London, commenting on the decision, says: "Trade union policy appears to have been examined and to have been found wanting; a long spell of immunity has favored the adoption of tyrannical methods; while immunity from liability to pay damages has caused the accumulation of strike funds which give the unions enormous power. A careful study of recent decisions may induce these bodies —which are upon the whole, to use Lord Lindley's words, organs for good—to bury the hatchet and adopt a policy of peace, retrenchment and reform."

NEW PUBLICATIONS.

Engineering Contracts and Specifications, including a brief synopsis of the law of contracts and illustrative examples of the general and technical clauses of various kinds of engineering specifications. By J. B. Johnson, C. E. 566 pages, 6 in. x 9 in. Engineering News Publishing Co., New York.

The author has done conscientious work in revising this third edition, so that it is now both a treatise and a handbook. All the clauses in most kinds of engineering contracts are discussed, the principles of law and of justice that govern them, and the simplest wording of such clauses. He has added value by giving in Part IV. 23 illustrative examples of complete contracts and specifications. This accurate and thorough work is typical of Professor Johnson, and it is pitiful to think that it is his last work. He died in June, 1902, the month in which he finished the revision. A portrait and a sketch of his life appeared in the *Railroad Gazette* for July 4, 1902.

The Great Siberian Railway, from St. Petersburg to Pekin. By Michael Myers Shoemaker. 243 pages, 6 in. x 8 in. New York: G. P. Putnam's Sons,

The interest in this book of travel centers in the journey from Moscow to Port Arthur made less than a year ago over the scarcely completed lines of the Siberian and the Manchurian railways. Leaving Moscow on April 24 at 10 p.m., he went "all rail," excepting the crossing of Lake Baikal, and reached Port Arthur, 5,150 miles, on May 13 at 1 p.m., and his story of it is good. It is that of a man whose eyes were wide open and whose mind was quite unprejudiced. Of the almost unbelievable mineral wealth of Siberia, of its uncivilized people, its wild animals and fish he got information from those who knew. Of the railroad, its location, construction and operation he was a good observer. His father was one of the builders of the Kansas Pacific Railroad.

The 2,000 miles from the western frontier of Siberia to Irkutsk is a generally level or gently rolling country, but the road cost $25,000 a mile, although its rail weighs only 54 lbs. per yard. It is a pitiful waste to have built it in this way, and it is already proposed to relay it, but probably under the peculiar circumstances it was the only feasible way to accomplish the greatest single piece of railroad building ever carried out. Lake Baikal, at Irkutsk, nearly the largest fresh water lake in the world, is, and will for an indefinite time be crossed by steamer. For the past seven years surveys have been made for the roads through the mountains around it, but no acceptable route has been found.

About 500 miles east of Lake Baikal the Siberian line enters the Chinese province of Manchuria, crossing nearly due east to Vladivostok, but branching nearly due south to Port Arthur and Peking. The story is well told and repays reading.

TRADE CATALOGUES.

The Hilo Railroad Co., Hawaii, has issued an attractive little illustrated pamphlet which contains pictures and a description of the Islands, with particular reference to the localities reached by the railroad. The total length of line now worked is 50 miles. For copies of the pamphlet address B. F. Dillingham, President, Hilo, H. I.

The Ajax Metal Company, Philadelphia, has just issued a handsome 66 page catalogue which contains much useful information regarding the theory of bearing metals. Complete descriptions of the various products of this company are given. It is stated that 4,000,000 lbs. of "Plastic Bronze" has been sold during the past two years. Several extracts from articles which have appeared in the *Railroad Gazette* on bearing metals are given, and the last 17 pages are devoted to a paper on "The Microstructure of Bearing Metals," by Mr. G. H. Clamer, Chemist to the company. This is reprinted from the Journal of the Franklin Institute.

Continuous-Light Semaphore Spectacles.—This is the title of Bulletin No. 11 just issued by the Union Switch & Signal Co., Swissvale, Pa., showing the latest designs of semaphore castings made by this company. Elongated or other irregular shapes of glass are discarded and only round glasses are used in semaphores: two round glasses close together answering the same purpose, practically, as a single oblong glass.

The Duff Manufacturing Co., Pittsburg, Pa., has issued Catalogue D, dated February, 1903, in which are described several types of the Barrett jack, of which this company is the exclusive maker. Each particular form of jack is illustrated, together with the detailed parts and a description and price list for ordering. These tools are in extensive use on railroads and each is designed especially for the work intended to be done. Their simplicity and rapid action make them particularly useful for track work and under journal boxes, or, in fact, any place where a jack is used. A number of special forms for oil wells, armature lifting, traversing bases, etc., are also shown.

Brown & Sharpe Mfg. Co., Providence, R. I., has published a new and revised edition of their pocket catalogue of machinery and tools for 1903. Many changes in the old catalogue have been made and much new material added. The principal additions to their already large and complete line of machinery and tools have been printed on a colored insert. As usual the book contains numerous useful tables and much general information, which makes it a valuable reference book to the workman. It contains 489 pages and has an excellent index.

Jenkins Bros., New York, who make a great variety of valves, packings and other steam and pipe fittings, show many of their standard and special products in an 80 page pamphlet just sent out and dated 1903. The Jenkins valves are made in all sizes and may be had for any service, steam, gases, water, acids or oils. Complete tables of sizes, prices and instructions for ordering are included, and there is a good index.

The DeLaval System for Train Lighting is the title of a pamphlet issued by the New York Headlight and Train Lighting Co. The DeLaval turbo-generator system is claimed to be especially adapted to the lighting of trains, tug boats and all vessels, one important reason being that the sets are free from vibration and are very economical. Among other engravings shown is one of

a 30-h.p., 20-k.w. set installed on one of the "Pennsylvania Limited" trains. The pamphlet announces also a new electric headlight.

The Hazard Mfg. Co., 50 Dey street, New York City, maker of wire rope, telegraph wire, insulated wire and cables, has issued a convenient pocket book designed to serve the double purpose of a memorandum (it contains 40 or 50 blank pages) and a reference book of convenient facts for telegraph and signal inspectors and repair men. A large part of the printed matter is devoted to a detailed catalogue of goods made by the company; but it also contains useful tables of weights and gages of wire, electrical resistances, measures of work, measures of weight and of pressure; and convenient mathematical tables.

The St. Louis Expanded Metal Fireproofing Co. has just issued a new catalogue on Steel-Concrete Construction Using Corrugated Bars and Expanded Metal which is much more comprehensive in its scope than the little pamphlet issued last fall on the "Uses of Expanded Metal." Five different systems of construction are described and illustrated, and their application to almost every form of structure is shown. These include pitch roofs, roundhouse roofs, wharves and docks, sidewalks, reservoirs, sewers, dwelling houses, dams, sea walls, oil tanks, elevated railroad structures, etc. There is a theoretical discussion giving the derivation of formulæ for the designing of steel-concrete beams of either rectangular or T section. Simplicity was aimed at to enable their ready application. The address of the St. Louis Expanded Metal Fireproofing Co. is 606 Century Bldg., St. Louis, Mo.

The Coughlin-Sanford Switch Co., Broad Exchange Building, New York City, has just issued a 32-page catalogue. It measures 6 in. by 9 in. and contains full description and illustrations of the Coughlin swing rail frog (which gives a continuous main line), and of a new interlocking system for protecting facing switches at outstanding points on main line.

The Railway Signaling Club.

The regular March meeting of this club was held in New York City on Tuesday last. President H. C. Hope was in the chair and there was an attendance of about 50. Seventy-two new members were elected.

The questions concerning adequate block signaling for fast trains, as outlined by Mr. H. M. Sperry and published in the *Railroad Gazette* of Feb. 27, were taken up seriatim and discussed informally. On the first point, the question of using an overlap where a distant signal is employed, Mr. W. H. Elliott, who was not present, sent a letter, stating that on the Chicago, Milwaukee & St. Paul the overlap has been used ever since the company first installed automatic signals. On the same principle that a space is always provided between a home signal and a derail, a space is needed between an automatic home signal and the potential fouling point ahead, which is the rear car of the supposed standing train. At the St. Louis meeting, two years ago, said Mr. Elliott, the weight of opinion was against the use of the overlap; but the C., M. & St. P. is satisfied that it should be used and that it is worth the additional cost. Near a large terminal, where no distant signals are provided, the overlap is made 1,500 ft.; with automatic block sections two miles or three miles long, and provided with distant signals, the overlap is made 1,000 ft. With block sections of less than 1.5 miles the overlap is made 600 ft. long. The Milwaukee road now has distant signals at one place 3,000 ft. back from the home signal and another is soon to be put in which will be 4,000 ft. distant; a separate post is used, if necessary.

The discussion was participated in by Messrs. Lane, Ten Eyck, Rosenberg and others. Mr. Sperry's main argument was that as discipline cannot be made absolutely perfect the safety of the passengers in the rear car of a train demands that there be some distance through which a train may run after it passes a stop signal. Mr. Sperry did not specify any length of overlap, but seemed to regard 800 ft. as the minimum length desirable. The arguments against the overlap centered in the statement that, as it practically leaves the engineman with a variable distance in which to stop, it introduces an uncertainty; and an uncertainty is a danger. The advocates of the overlap said that the engineman should still be required to stop *at* the signal, to which it was replied that you could not conceal from the runners the existence of the overlap. They would know that it was there, and would look upon it as a protection to them, permitting them to run past the signal. Mr. Sperry replied to this that the perfect discipline which is necessary without the overlap, and which his opponents said was practicable, could, with equal reasonableness, be said to be available to compel enginemen to obey stop signals, notwithstanding the existence of an overlap. Then the overlap would fulfil its most important function, of providing against those rare cases where signals are overrun, notwithstanding the employment of competent and trustworthy enginemen and the enforcement of the best discipline.

Mr. Ten Eyck brought out the point that with a block section, say, three miles long, and with a distant signal 2,000 or 3,000 ft. back of that, and, thirdly, an overlap of, say, 1,000 ft. beyond (ahead) of the block section, trains would be kept a long distance apart. This phase of the subject was not much discussed.

The question of what the length of the overlap should be was also passed over with but little consideration, though the trend of the discussion was that where speeds are ordinarily high it should be longer than at places; like the approach to terminal stations, where they are almost always moderate. Comparisons being made with English practice, it was pointed out that the requirement that a train must have passed both the home and starting signal at station B before the following train can leave station A is a significant recognition of the value of the principle of the overlap; and it was argued that this feature of English practice should be taken as a powerful argument in favor of the overlap.

Mr. Sperry, in concluding the discussion, summed up by saying that if we can stop our trains, where we wish to, by the simple force of discipline, we do not need the overlap; if we cannot, we need some mechanical provision. It was then moved that it was the sense of the meeting that the overlap was not needed in American surface railroad practice; and this was carried by a vote of 22 to 6. One of the speakers thereupon observed that the majority members had shown by their votes a profound confidence in the efficiency of American railroad discipline.

On Mr. Sperry's second question, Whether or not automatic stops should be used, the discussion was quite brief, a member pointing out that if, as the meeting had just declared, the overlap was not necessary, the state of discipline must be so good that we ought to assume that the automatic stop is still more unnecessary. Mr. Kinsman, the maker of a well-known automatic stop, was present and was allowed to briefly address the meeting in behalf of his device. He enlarged on the subject of human fallibility and the certainty that every man's brain now and then gets on a dead center. He said that he no longer advocated the use of an automatic device like his own without the use of a visual signal. He provides a registering device with his stop, so that it is possible at the end of each trip to show just what has been the situation at each signal passed by a locomotive. After further brief discussion a motion was made that the automatic stop, as thus far developed in this country, is not adapted to use on surface railroads. This was briefly discussed and the meeting finally voted that the President appoint a committee of five to investigate the subject of automatic stops and with power to draw up specifications of what should be required in such a device; the committee to report at a future meeting. After this, a motion was carried that a committee of five be appointed to take up the question of discipline of enginemen; to investigate and report, and particularly to find out if inspectors of enginemen's conduct make formal written reports.

Audible signals were briefly discussed. It was stated that torpedoes, as now used in the Fourth avenue tunnel, New York City, give satisfactory results. Two torpedoes are used at each point, one on each of the two rails. In the tunnel a bell or gong is not satisfactory, although very large ones have been used. Mr. H. Raynar Wilson, of London, who was present, stated that Raven's locomotive-cab fog-signal, consisting of a whistle, which is used on the North Eastern of England, had not yet had an opportunity to fully show its merits, because there had been so little fog during the past two or three years. All of the engines on an important division are equipped, but the safeguard of requiring men, with torpedoes, at all signals during fogs, has not been relaxed.

The fifth question, "Uniform Location of Signals," was discussed only briefly, but Mr. Ten Eyck explained the practice of the New York Central on its four-track lines, where the overhead bridges, spanning the four tracks, which were put up about 10 years ago, are being gradually abandoned and superseded by bracket posts. On this road the two outer tracks are used by eastbound trains and the two inner by westbound. With the bridge arrangement a westbound engineman at night finds two lights side by side, one of which governs his track. An objection to this arrangement is the danger of a mistake in case one of the lights is obscured; and it was partly to avoid this that signals were placed on posts outside of all the tracks; though the new arrangement is far from ideal, because, on one track in each direction, the enginemen find their signals on their left hand. Mr. Wilson explained the practice in England as to the use of signals on bracket posts. The use of brackets, in the way that they are used in this country, is not common in England, except where necessary to set a signal out from among trees or other objects which would obscure the view.

The fourth question, "Engine Cab Signals," was not discussed. On the subject of green for all-clear, the testimony was all one way, and indicated nothing new; that is to say, those who use green like it, and those who do not, say that they are preparing to use it. But the adoption of suitable blade grips is the only practical action that these people have taken in this direction. Mr. Wilson said that the use, in England, of the same night colors in distant signals as in home, although it has never been shown to be dangerous, does give the operating officers some concern, and a Clearing House Committee is considering the question of making a difference between the home and distant.

The practice of the Delaware, Lackawanna & Western, and other roads, in blinding the lights of semaphore arms which indicate for diverging routes, was briefly considered. Mr. Wilson said that the objection to multiplicity of red lights, spoken of by Americans, was also a live question with English railroad men, and he thought that the blinding of minor lights was a move in the right direction. Nevertheless, any two signals at the same point have a relation to each other and caution must be exercised in obscuring either or any one of the signals in such a group.

This was the only discussion on Mr. Sperry's seventh question; and the eighth question was not discussed at all. The meeting adjourned at 6 o'clock; but there was an informal session in the evening which was enjoyed by a large proportion of the members who were present in the afternoon.

British Railways as Business Enterprises.*

Whatever else the railroads of the United Kingdom may be—great engineering works, elaborate pieces of mechanism, potent economic forces, revolutionizers of social and business habits, great employers of labor, indispensable public servants—they are all these, but, first and foremost, they are commercial undertakings, business enterprises, established to earn dividends for those who have supplied the capital to create them.

This is the characteristic feature of the railroads of this country, the feature which differentiates them from the railroads of a great part of the rest of the world. On the continent of Europe, and in our own colonies, the railroads are, speaking generally, the property or the child of the State, and the earning of profit on the capital invested is consequently of less importance than the rendering of efficient public service, the fostering of native industries, or the protection of the country in time of war. Even in America, the only part of the world besides the United Kingdom which owes its railroad system to private enterprise, the earning of a dividend for shareholders is usually of secondary importance compared with other ends which those who control the policy of the lines have in view, such as the carrying out of great industrial schemes, in which cheap transportation is an essential factor, the opening up of undeveloped territories, or the aggrandizement of individuals. A great part of the capital invested in American railroads, too, has been raised not by shares but by bonds, and bondholders have no voting power.

In this country we have secured, under Parliamentary supervision, a commercial system of railroad transportation which, for an industrial community such as ours, has a big balance of advantage over a State-owned system, a State-guaranteed system, a millionaire-managed system, or any other system which exists or you can imagine. But if you are to retain this system you must treat it fairly. It is a hardy plant and can stand rough weather, but it cannot remain sterile. It must bear fruit or it will inevitably wither. Give the investor a fair dividend and he will go on finding the capital for new lines and improvements. But if by legislation or local persecution you render railroad shares no longer profitable, then the only alternative is a State system of railroads, which is alien to the genius of a highly organized commercial community such as ours.

The prime consideration with the shareholder is, as we have already remarked, his half-yearly dividend. He wants the highest return possible on his investment, and he does not want to wait for that return longer than can be helped. Hence, owing to the predominance of the shareholders' influence upon English railroad policy, it has always been the custom to divide the profits of each half-year or year "up to the hilt," subject only to a more or less liberal current expenditure for the maintenance of the property.

Now, opinions may and do differ as to whether "betterment" is a legitimate revenue charge, and as to where exactly the line between revenue and capital charges should be drawn; but, speaking broadly, the English railroad practice has always been to give the dividend "the benefit of the doubt," and it has now become pretty clear that under this system too high distributions have been made to the shareholders in the past, and that by the amounts so abstracted (plus compound interest thereon) the capital accounts have been unduly inflated. To a certain extent, no doubt, the present shareholders are paying for this by receiving lower rates of dividend than they would have had if their predecessors had not capitalized charges which they ought to have paid for outright; still, the traveling and trading public may fairly argue that they, too, are bearing a burden which ought never to have been put upon them; in other words, that the fares and rates charged to the public have to provide interest for a certain amount of capital which would never have come into existence if a sounder and more far-sighted financial policy had been pursued from the start.

The question is a difficult and complex one, and whilst convinced that the British practice has led to over-capitalization, I am not prepared to say that the practice lately introduced by certain American railroad administrations of having three accounts: "maintenance," "betterment," and "extension,"—the first two revenue accounts and the third a capital account—is a proper remedy for the evil. For this leaves the rate of dividend payable to the shareholders at the absolute discretion of the directors, who can enlarge or contract the betterment account exactly as they think fit, thus making the divi-

*Extract from the eighth of a series of "Lectures for Business Men," delivered in connection with the Faculty of Commerce of the University of Birmingham, by Charles H. Grinling.

dend practically little more than an optional "bonus." Such a course may be practicable in a country where the railroad shareholder's power is mainly nominal, and where the Presidents of the roads are practically autocrats; but, applied to British conditions, it would probably involve a fight at the shareholders' meeting over every dividend which the company declared. If it did not involve endless controversy, the change would probably lead to nothing more than the calling by the name of "betterment" of a part of the expenditure which is now provided for under the head of "maintenance." It is not human nature to expect that a body of shareholders will vote away their dividends for the sake of posterity, or even for their own benefit in a more or less remote and uncertain future.

It is too late to put the matter right now as regards the past, and both the shareholders and the customers of our railroads must make the best of a condition of over-capitalization which has arisen, not out of financial chicanery, as in America, but from mere ignorance of the science of accounts, fostered by the practical necessity under a commercial system of giving the pioneer investors as high a return as possible on their money in order to encourage further investment. For the future, however, the matter should, wherever possible, be put on a sounder footing, though a certain amount of self-denial on the part of the present shareholders must be involved in the process of reform; and certainly, new companies such as the electric railroad companies which are springing up in London should see to it that they do not repeat the old errors. To this end it is of the highest importance that Parliament and the public generally should grasp the fact that our railroad companies, so far from being "bloated monopolists," to be plundered on all hands, have been reduced by recent legislation and a combination of adverse conditions, to the position of a threatened industry, the proper development of which may be seriously checked if speedy relief be not given from some of the burdens which have been placed upon its back.

Steel Rolling Doors.

Easy rolling is perhaps the most important requirement to be possessed by a rolling shutter, and depends upon the formation of the joint between slats. In the design of Mr. Peter Ebener, of Columbus, Ohio, each hinge is given two bearings, the form being one that is thought to produce the least amount of friction. The barrel or cylindrical formation gives added stiffness to the structure, and the bead within the barrel prevents separation of the slats. The durability of the door is dependent upon both of these features, and upon the further one that the slats must be so formed that they will readily shed all water, snow, sleet, etc., preventing deterioration from such sources.

The material is 22-gage sheet steel, cut in 3⅜-in.

Fig. 1.

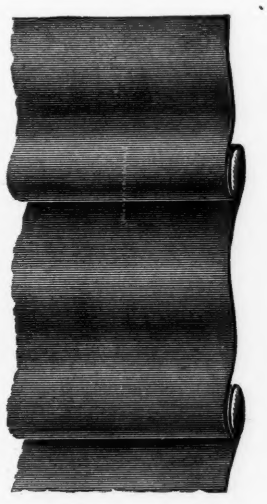


Fig. 2.

strips, and rolled in a special machine. The strips pass through seven separate rolls, and may be of any length desired, the length of strip, of course, determining the width of door.

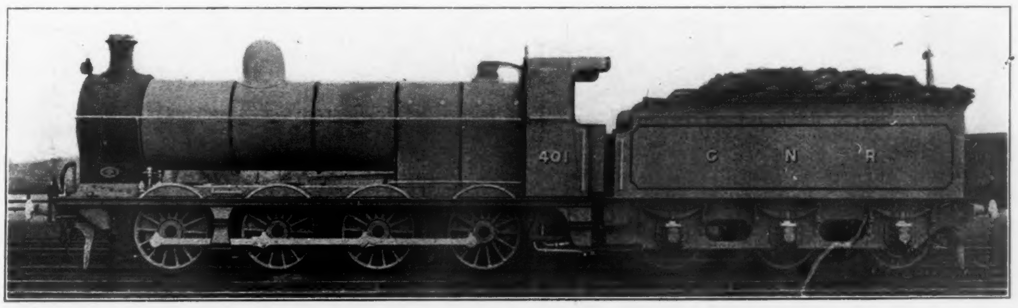
The roller upon which the door is wound up is formed of tubing 3 in. in diameter or greater, depending upon the width of the door. Counter-balancing springs are placed within the rollers. There are two forms of gearing for raising and lowering the doors, depending upon whether the door be inside or outside hung. For the former a gear is attached to the end of the roller, outside of the supporting bracket. Engaging with this gear is a pinion cast integral with a sprocket wheel, over which latter a hand chain passes, swinging within a short distance of the floor. Where the door is outside, the sprocket wheel is mounted on a shaft, which runs through the wall, and has on its outer end a bevel pinion engaging a bevel gear on the roller. The gearing is protected by a suitable case. A protecting hood for the rollers is formed of sheet steel and is secured to the supporting brackets.

Steel doors form a good protection against fire, and where this design is put in for that special purpose and not for daily use, a special provision holds the door rolled up until the melting of a fuse releases it.

These doors are being made by the Columbus Steel Rolling Shutter Co., Columbus, Ohio, which was organized last June. The officers are Samuel P. Elliott, President; J. W. Cartzdafner, Vice-President; S. A. Webb, Secretary; H. F. Miller, Manager; Peter Ebener, Superintendent. They have recently equipped buildings for the new shops at Columbus of the Pennsylvania Lines West of Pittsburg; shops and freight sheds of the Hocking Valley at Columbus; a number of power houses and car sheds for interurban electric lines in the Central States, and several large warehouses and department stores in Columbus. The company will shortly move into a new plant, providing increased room and improved facilities.

An Eight-Coupled Mineral Locomotive of the Great Northern.

Our illustration shows a new eight-coupled mineral traffic locomotive that has recently been put in service on the Great Northern, England. It is the design of Mr. H. A. Ivatt, Locomotive Superintendent, and was built at the Doncaster shops.



Eight-Coupled Mineral Locomotive—Great Northern Railway of England.
(Designed by MR. H. A. IVATT, Locomotive Superintendent.)

The controlling grade on the route over which these engines work is 26 ft. to the mile in both directions. An average load is about 52 loaded cars, having a gross weight of 800 tons and a paying load of 520 tons. The old six-coupled engines which these new ones displaced were only capable of handling about 530 tons over the same section.

The total weight in working order is 122,185 lbs., all of which is on the drivers. The cylinders are 20 x 26 in., and the boiler pressure is 175 lbs. per sq. in. The total heating surface is 1,439 sq. ft., about 9½ per cent. of which is in the fire-box. The grate area is but 24½ sq. ft., which indicates a narrow fire-box. The tubes are 2 in. in diameter and are 13 ft. long.

The wheel base of the engine is 17 ft. 8 in. The drivers are 55½ in. in diameter. The coal capacity is five tons and the tank holds 3,670 imperial gallons.

Our English correspondent tells us that they are giving excellent satisfaction.

An Improved Design of Shovel.

The Avery Stamping Co., Cleveland, Ohio, has recently produced a plain back shovel having the blade and socket forged from one piece of steel. The object of this is to eliminate the weak point, the junction of the straps and blade. When the old back strap wears through the tool is weakened. By the new process, after the blade is forged a piece of steel is welded to the back and is carried up under the socket, being there encased with the handle. No wood shows at all at the joint between handle and socket. In making these shovels, and, in fact, all of the shovels, spades and scoops of the company, each individual blank is rolled separately, instead of rolling the sheet in packs of five or six, as is commonly done. This individual treatment brings both sides of the blank in contact with the rolls, imparting to the blade greater stiffness, toughness and density; very desirable qualities in such tools.

Another advantage claimed is in the reduction of leverage by bringing the user's hand much closer to the load than has previously been done. This gives a better balance, enabling the user to do more effective work with less effort. A hollow-back shovel, called the "Cleveland," is also made by this company. All of its shovels, the latter class as well as the smooth-back, are made in four regular grades. An extra heavy kind is made for railroad use.

Tests and Inspection of Cast-Iron Wheels.

BY C. W. GENNET, JR.

Wheels for inspection should be arranged in rows of the same date of casting. Preferably the rows should be far enough apart to permit of passing easily between them, which facilitates the trying of the limit gages handily on the flanges for about seven-eighths of the circumference and thus to inspect the treads and throats for the appearance of sand spots, chill cracks, and other imperfections of the wearing surface that are a menace to economy and frequently dangerous. The writer has seen wheels in service which have had to be removed because of sand spots appearing on the treads which might and should have been discovered at the time of inspection. These sand spots may be due to the washing down to the chill of particles of sand or even of the core, which particles are not allowed to rise there because of sluggish iron at the time of pouring. They are not infrequently hidden by a film of iron and are generally deceptive because of color. If they appear in the throat the strength of the weakest part of the wheel is much lessened. Chill cracks are hard to detect in the new wheel and should not be confused with the marks left on the tread by a rough chill or the sweat marks caused by the excessive use of oil on the surface of the chill. The inside and outside of the wheels should be carefully examined for defective foundry practice usually evidenced by blow holes and sand spots, and to aid in this matter if the wheels are rightly set up in rows they can be easily tilted in the opposite direction, thus exposing the inside and outside.

Most specifications rely on the drop test as the means of detecting inferior wheels. This test should be made with care and discretion for the results of it are generally the basis of the acceptance or rejection of a considerable number. Preferably wheels of low shrinkage should be used for it and it is desirable to use a wheel that appears sound and good. Obviously if a wheel of the lowest shrinkage in the lot is used, the depth of chill shown by the fracture is the lowest and thus a check is afforded on that point. If the wheel fails it is a correct supposition that the wheels of higher shrinkage would fail quicker, which is generally borne out in the trials. The drop test wheel should rest perfectly level on the anvil and the blows be delivered centrally in the same place over the hub. Notice should be taken of the tup used to see that its striking face is not curved to such an extent as to admit it the slightest amount into the axle hole. A case is known where some tested wheels were apparently very tough as evidenced by the number of blows required to break them; but investigation later showed that carelessness and neglect were the real causes of toughness, for the tup used was curved so as to make it act as a wedge, each blow driving it deeper into the axle hole until the wheel was finally forced apart and not broken in the true sense of the specification. Warming wheels in cold weather before testing them is a somewhat questionable practice and must be left largely to the inspector's judgment. If heating is not considered as a disadvantage in getting a fair test, care should be taken to get the heat distributed evenly throughout the wheel.

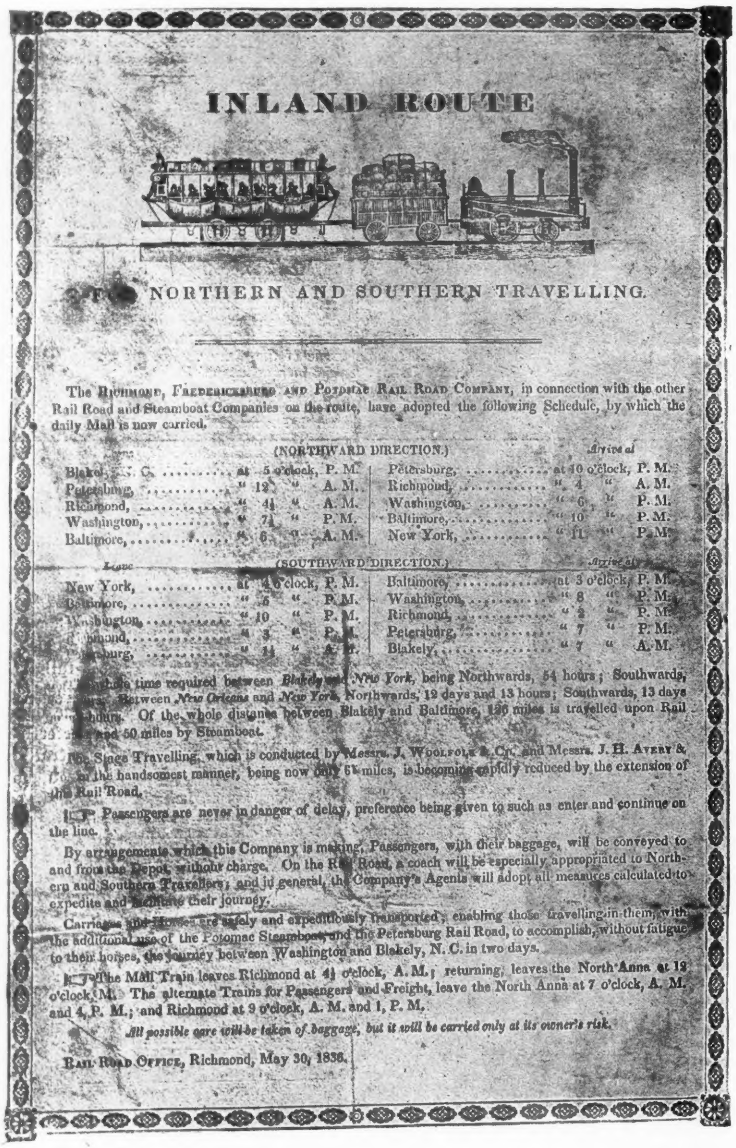
When broken, the fracture should be closely examined for the character of the iron and depth of chill. When placed in the sunlight the desirable soft gray iron will sparkle like jewels and have an appearance of toughness and strength somewhat different from ordinary unannealed castings. It will blend into the clear white iron of the chill with no perceptible line of demarcation and it will be found impossible to say exactly what the depth of chill is, so nicely will the chill and gray iron blend together. Mottled iron should be closely watched for and the least indication of the undesirable hard iron should be just reason for testing another wheel of higher shrinkage. The shifting of the cores, causing plates of unequal and uneven thickness; variation in the depth of the chill; and the freedom of the wheel in general from blow holes, dross and poor foundry practice, are points that can be readily brought to light after the wheel is broken.

The hardest and most severe test a wheel can be put to is the thermal test. Wheels of high shrinkage, that is, wheels under high tension, as evidenced by the deepest chill, are preferable for thermal tests. They should not be perceptibly heated before testing and it will be found that a thin coating of shellac on the tread will serve practically the same purpose as heating in cold weather. Care should also be taken here to have the wheel perfectly level in the sand which should be fairly green and well mixed. When the iron is poured it should be as hot as can readily be obtained from a large ladle. It should be free from slag and poured as rapidly as possible, preferably into a trough so arranged as to feed to the tread at several points and to fill it as quickly as it can be. After the specified interval, from the time that the pouring ceases, the ring should be removed and the wheel closely examined for cracks and causes for rejection or a re-trial.

With a good set of specifications to cover the points involved and with the judgment of a good inspector it will be found that much can be accomplished to not only lessen wheel failures but to prolong the life of wheels.

The Richmond, Fredericksburg & Potomac in 1836.

The accompanying reproduction of the Richmond, Fredericksburg & Potomac time-table for 1836 contains provisions for the welfare of passengers which sound fully as liberal as in vogue to-day. For example, "By arrangements which this company is making, Passengers, with their baggage, will be conveyed to and from the Depot without charge. On the Railroad, a coach will be especially appropriated to Northern and Southern Travellers; and in general, the company's Agents will adopt all measures calculated to expedite and facilitate their journey." Passengers are further assured that all possible care will be taken of their baggage, and that they are never in danger of delay! It may be noted, however, that the run-



INLAND ROUTE

[illegible] NORTHERN AND SOUTHERN TRAVELLING.

The RICHMOND, FREDERICKSBURG AND POTOMAC RAIL ROAD COMPANY, in connection with the other Rail Road and Steamboat Companies on the route, have adopted the following Schedule, by which the daily Mail is now carried.

(NORTHWARD DIRECTION.)

Leave		Arrive at	
Blakely, N. C.	at 5 o'clock, P. M.	Petersburg,	at 10 o'clock, P. M.
Petersburg,	" 12 " A. M.	Richmond,	" 4 " A. M.
Richmond,	" 4½ " A. M.	Washington,	" 6 " P. M.
Washington,	" 7½ " P. M.	Baltimore,	" 10 " P. M.
Baltimore,	" 6 " A. M.	New York,	" 11 " P. M.

(SOUTHWARD DIRECTION.)

Leave		Arrive at	
New York,	at 4 o'clock, P. M.	Baltimore,	at 3 o'clock, P. M.
Baltimore,	" 5 " P. M.	Washington,	" 8 " P. M.
Washington,	" 10 " P. M.	Richmond,	" 2 " P. M.
Richmond,	" 3 " P. M.	Petersburg,	" 7 " P. M.
Petersburg,	" 11 " A. M.	Blakely,	" 7 " A. M.

The whole time required between *Blakely* and *New York*, being Northwards, 54 hours; Southwards, [illegible] hours. Between *New Orleans* and *New York*, Northwards, 12 days and 13 hours; Southwards, 13 days [illegible] hours. Of the whole distance between Blakely and Baltimore, 126 miles is travelled upon Rail [illegible] and 50 miles by Steamboat.

The Stage Travelling, which is conducted by Messrs. J. WOOLFOLK & Co. and Messrs. J. H. AVERY & Co. in the handsomest manner, being now only 6[illegible] miles, is becoming rapidly reduced by the extension of the Rail Road.

Passengers are never in danger of delay, preference being given to such as enter and continue on the line.

By arrangements which this Company is making, Passengers, with their baggage, will be conveyed to and from the Depot without charge. On the Rail Road, a coach will be especially appropriated to Northern and Southern Travellers; and in general, the Company's Agents will adopt all measures calculated to expedite and facilitate their journey.

Carriages and Horses are safely and expeditiously transported; enabling those travelling in them, with the additional use of the Potomac Steamboat, and the Petersburg Rail Road, to accomplish, without fatigue to their horses, the journey between Washington and Blakely, N. C. in two days.

The Mail Train leaves Richmond at 4½ o'clock, A. M.; returning, leaves the North Anna at 12 o'clock, M. The alternate Trains for Passengers and Freight, leave the North Anna at 7 o'clock, A. M. and 4, P. M.; and Richmond at 9 o'clock, A. M. and 1, P. M.

All possible care will be taken of baggage, but it will be carried only at its owner's risk.

RAIL ROAD OFFICE, Richmond, May 30, 1836.

ning time between Richmond and Washington, in 1836, was 13½ hours; in 1903, it is three hours and five minutes.

TECHNICAL.

Manufacturing and Business.

The capital stock of the Simplex Railway Appliance Co., Hammond, Ind., has been increased from $750,000 to $1,500,000.

The United States Metal & Manufacturing Co. has discontinued its branch office at Buffalo and opened an office at Pittsburg. The new office is in charge of E. L. Caton.

The American Steel Foundries Co. through its Southern sales agent, T. N. Motley, 12 John street, New York, has furnished the Chesapeake & Ohio 2,000 cast steel bolsters of special design.

The Springfield Ry. & Light Company has been incorporated in New Jersey, with a capital of $3,000,000. F. R. Hansell, Jos. T. Cutter and William F. Eidell, all of Camden, N. J., are incorporators.

The American Steel Foundries Co., through its Southern agent, W. R. Gravener, has had cast steel bolsters and Thornburgh attachments specified on 226 cars for the Atlantic Coast Line.

The St. Paul Railway Supply Co., with $250,000 capital, has been incorporated by Frank C. Towns, St. Paul, W. P. Crockett, Chicago, and Louis Dunn, St. Paul, to make the Dunn frog and switch and deal in other railroad supplies.

The C. P. Hoffman Construction Co., Bangor, Pa., capital $5,000, has been chartered by C. P. Hoffman, C. N. Miller, Jno. N. Hoffman, Conrad Miller, J. A. Miller, H. M. Bennett and J. I. Heintzelman, to build steam and electric railroads and bridges.

Contract has been let to the Safety Insulated Wire & Cable Co., of New York, for about 1,100 miles of submarine cable for the Signal Corps of the Army. This cable is to be made entirely in this country and to be used between Puget Sound and Alaska.

The New York Continental Jewell Filtration Co. has received orders for water purifying plants as follows: For His Majesty the Khedive of Egypt, for the Royal Palaces at Mantaya, near Alexandria; Royal Hungarian R. R. Klausenberg, Hungary; Mutual Life Ins. Co., Cape Town, So. Africa. The company will soon install three large plants in Philadelphia and one at Cornell University, Ithaca, N. Y.; also for the Water Works Company at Columbus, Ga., a filter plant of 2,000,000 gallons daily capacity.

Kilburn, Clark & Company, of Seattle, Wash., have been made the Pacific Coast sales and distributing agents of the Nernst Lamp Company, of Pittsburg, and have established branch offices in San Francisco and Los Angeles, Cal. The Nernst Company has secured patent and selling rights in Canada, and is making arrangements for establishing a factory in the Dominion for the manufacture of its lamps.

A new insulating compound called "Dielectrol" has recently been developed. It is a liquid and is made especially for copper coils. It is claimed to possess absolute chemical inertness, which makes of it a permanently elastic compound, and from which there is no chemical action upon the copper coils. It is already in use and it is made by the Dielectric Manufacturing Co., 3820 Manchester avenue, St. Louis, Mo.

The General Pneumatic Tool Co. is a reorganization of the business of the Havana Bridge Works at Montour Falls, N. Y. The new company will make pneumatic tools, compression riveting machines, pneumatic motor hoists, air compressors, cranes, etc. Extensive improvements to the plant were recently made and an additional building for use as a storehouse will be built soon. Robert T. Turner is President; C. F. Carrier, Vice-President; James A. Shepard, Secretary, and Frank A. Hatch, Treasurer.

In the extensive modifications and improvements to be made at the St. Louis Union Station in preparation for the Fair next year, Westinghouse, Church, Kerr & Co. will do all the mechanical and electrical equipment, a contract for the work having recently been signed. The contract is a large one and the time is short, the new and enlarged passenger station being required to be ready by April, 1904. The train shed will be extended over the main subway and there will be a double row of baggage elevators, 34 in number. Numerous branch subways will lead to the subsidiary buildings. The tunnel work is to be done by James Stewart & Co.

The Rushmore Dynamo Works, of Jersey City, manufacturing special electrical apparatus, Navy searchlights and the Lens mirror headlight, is moving into new shops at Plainfield, N. J. The buildings are of brick and iron and have about 20,000 sq. ft. of floor space. The power plant consists of a return tube boiler and 60 h.p. Ideal engine with a 15 h.p. Otto gas engine, driving two 25 k.w. Rushmore multi-voltage lighting and power dynamos. The headlight lens grinding machines and most of the tools have individual motor drive on the Rushmore system, which gives an infinite range of speeds without the use of rheostats or main current switching devices and thus requires a much smaller generating plant than with the usual system.

Iron and Steel.

The Dauphin Bridge Works, Dauphin, Pa., were destroyed by fire March 6.

The Jefferson Iron & Steel Co., of Philadelphia, has been incorporated under the laws of Delaware with $500,000 capital.

The Tennessee Coal, Iron & Railroad Co. will begin about April, according to report, to make rails at Ensley, Ala., at the rate of 10,000 tons a month.

We are informed that the plans for the reorganization of the William R. Trigg Shipbuilding Company, of Richmond, Va., are sufficiently matured to insure the re-opening of the works at an early date.

The Horsburgh Forging Co. has been incorporated at Columbus, Ohio, with a capital of $25,000. Incorporators, Robert Horsburgh, John H. Horsburgh, Frank Horsburgh, Hugh E. Paine and Fielder Sanders.

The Cooper-Hewitt Converter.

The Cooper-Hewitt static converter, or rectifier, which has lately been widely discussed by the electrical papers, promises to play an important part in the development of long distance electric railroading. Briefly stated, this device consists of a vacuum tube containing mercury vapor. Electrodes which project into the tube act as electric valves to an alternating current. That is to say, one-half of the alternating wave is dampened. Normally, the alternating current consists of a series of sinusoidal waves, alternating in direction. The new converter cuts out one-half of the wave and produces a direct current consisting of a series of impulses of the same sign and varying in intensity. We thus have a simple apparatus which converts an alternating current into a direct current. We can imagine that in its perfected form it will be possible to place one or several of these devices on the car in series, or parallel, with a single-phase alternating current, and thus eliminate the expensive and cumbersome rotary converter sub-stations. This would decrease the cost of line construction and improve the economy of transmission.

Naval Stations in Cuba.

An agreement has been signed by President Roosevelt for the United States, and previously by President Palma for Cuba, providing for the acquisition by the United States of a naval station at Guantanamo and a coaling station at Bahia Hondo, in Cuba, the necessary land to be acquired for the United States by the usual condemnation proceedings.

New Water Softening Plants for the Pittsburgh & Lake Erie.

The Pittsburgh & Lake Erie is arranging with the Kennicott Water Softening Co. to build eight water softening plants ranging from 20,000 to 40,000 gal. hourly capacity. All will be on the continuous flow system and located at Hazleton, New Castle Junction, Rock Point, Stobo, Groveton, Williamsburg, Buena Vista and Whitsett Junction. A plant is now building at McKees Rocks with an hourly capacity of 60,000 gal. The pumping stations at which these plants are to be built will be about one-half of the road's total number of water stations. It is the intention to ultimately equip all pumping stations owned by the road with water softening or purifying plants.

Remarkable Endurance of the Hasselmann Preservative.

In the *Railroad Gazette* of March 16, 1900 (page 163), we published some reports of the Imperial Chemico-Physiological Laboratory at Klosterneuburg, near Vienna, and of the Mechanico-Technical Laboratory of the Royal Technical High School at Munich, in support of the claim made by the Barschall Impregnating Co. that the preservative salts used in the Hasselmann process penetrate the fiber and cell tissues of the wood; that, being insoluble, they will remain there indefinitely. In an endeavor to learn whether or not timber so treated would resist the action of the Teredo Navalis, the Southern Pacific Co. on April 9, 1901, submerged, two feet below average low water in Galveston Bay, five Georgia pine ties treated by the Barschall Impregnating Co. Jan. 30, 1902, or nearly nine months after submersion, the ties were removed, and found to be partially consumed by Teredo. Last month these same ties were sent for chemical analysis to Prof. Gellert Alleman, agent of the Bureau of Forestry, U. S. Department of Agriculture, and Professor of Chemistry at Swarthmore College. Under date of Feb. 26, 1903, Prof. Alleman writes: "You may be interested to know that this wood, which was evidently treated by the Hasselmann process, still contains the insoluble in water iron salts. To me, this is extremely interesting, as

I was not prepared to believe that timbers so treated would resist the solvent action of ocean waters for such a time."

Signaling.

The Union Switch & Signal Company has lately taken several important contracts for automatic electric semaphore block signals. The contracts taken during the month of February aggregate 513 blades on 269 posts. These are to be installed on four different railroads. Something over 3,000 of these signals are now in use, but the art is constantly advancing and the signals that will be installed under the new contracts will be better than any that the company has yet put in service. The improvements in detail are mostly in the direction of economy of maintenance, and higher efficiency.

Railway Steel-Spring Company.

The general balance sheet of the Railway Steel-Spring Co. to Dec. 31, 1902, gives the following statement, which covers operations in the steel tired wheel department, the spring department and the rolling mills for the first ten months of the company's business:

Assets.	
Plants	$24,156,397
Merchandise on hand	1,282,824
Stocks and bonds	200,085
Accounts receivable	2,156,095
Other items	18,624
Cash	435,189
Total	$28,249,214
Liabilities.	
Capital stock, preferred shares	$13,500,000
Capital stock, common shares	13,500,000
Accounts payable	256,846
Reserved for pref. stock dividend, taxes, etc.	88,580
Surplus	903,788
Total	$28,249,214

Hereafter the business year will conform to the calendar year.

Steam Train Pipe and Connections.

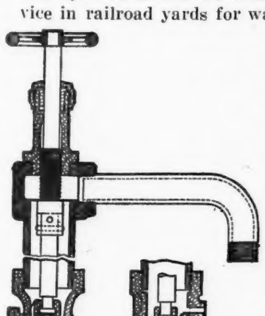
The committee of the Master Car Builders' Association appointed to investigate and report on steam train pipe and connections has sent to the members of the association a circular of inquiry containing 30 questions to be answered. From the replies received it hopes to make a complete report at the next convention. Copies of the circular may be had from Mr. H. F. Ball, Supt. M. P., L. S. & M. S., Cleveland, Ohio, who is chairman, and replies should be addressed to him.

Union Switch & Signal Co.

At the annual meeting in Pittsburg, March 10, the following directors were elected: George Westinghouse, George C. Smith, James H. Willock, William McConway, Robert Pitcairn, H. G. Prout, Thomas Rodd. The dividend rate was fixed, for the common stock, 1½ per cent. quarterly, and for the preferred stock, 2¼ per cent. quarterly.

Chapman Yard Hydrants.

The hydrant shown herewith is specially designed for service in railroad yards for washing cars, filling tanks, etc., and for any service where it is important to be able to shut off the water supply below the freezing line. The hydrants are self draining, so as to prevent freezing, and are provided with the Chapman automatic drip valve at the bottom of the post. This drip valve is turned by means of a bronze rod extending to the top of the hydrant and connecting with the screw, shown in the accompanying engraving. Another design is made in which the drip valve is opened by a lever and is self-closing. In Northern climates, where the frost line extends four or five feet below the surface, the distance from the center of the inlet pipe to the center of the outlet pipe is made about six feet. The outlet is usually set about 18 in. above the ground. The hydrant is made by the Chapman Valve Mfg. Co., Indian Orchard, Mass.



Bridge Inspection Methods.

A committee has been appointed by the Association of Railway Superintendents of Bridges and Buildings, to report at the next annual convention, at Quebec, in October, 1903, on the best method of making annual inspection of bridges and culverts, and the form of report to be made. The questions asked are as follows:

1. What is your system for current inspection of bridges, how frequently made, by whom, and specimen of report blanks?

2. Do you keep a regular bridge inspector for the current inspection of bridges?

3. What is your system for quarterly, semi-annual, or annual inspections, by whom made, specimen of report blanks, to whom are these reports sent, what use is made of same, and in whose office ultimately filed?

4. Is there any other special class of bridge inspection that you use or recommend?

5. What are the principal points examined in each class of inspection?

6. How is the inspection made, how does the inspector get over the road, what tools does he employ, etc.?

7. To what extent do you depend on the Track Department for current inspection of bridges and culverts?

8. Should culverts be inspected by the Bridge Department?

9. What is your minimum limit of an opening in the roadbed so as to be classed as a "bridge"?

10. To what extent should the masonry and foundations of bridges be inspected by the Bridge Department?

11. Brief outline of the organization of the Bridge Department on your road.

All communications are to be addressed to Walter G. Berg, Chief Engineer, Lehigh Valley, 26 Cortlandt street, New York. Mr. Berg is chairman of the committee, on which he is associated with J. A. Dodson, C. F. Loweth, A. Montzheimer, A. Zimmerman, A. Shane, and I. O. Walker.

THE SCRAP HEAP.

Notes.

The Lake Shore & Michigan Southern has increased by 5 or 10 per cent. the pay of a large number of stationmen.

The hearing on the motion to dissolve the injunction against the Brotherhoods of Firemen and Brakemen, restraining them from ordering a strike on the Wabash Railroad, is set for March 17.

The United States Court at St. Paul has dismissed the indictments returned several months ago against the Wisconsin Central and Ann Arbor railroads on complaint of the Interstate Commerce Commission.

Press despatches from Columbus, Ohio, report that a decision of the Supreme Court of that State handed down March 3 decides adversely to the claim that railroad relief associations are carried on by unlawful methods.

The Mississippi River is now very high; and at Memphis, March 9, there was a conference of engineers in charge of the levees. A patrol was established between Cairo and the mouth of the White River, a distance of 100 miles.

The Interstate Commerce Commission is to hold another hearing on the complaint of the Kentucky Railroad Commission, that the action of the Atlantic Coast Line, in virtually consolidating with the Louisville & Nashville, is illegal. The hearing will take place in New York March 27.

The Atchison, Topeka & Santa Fe has announced the usual cash prizes to station agents who have made the largest increases in business during the past year (ending Dec. 31). The first prize goes to Mr. McMillan, of Elgin, Kan. This is $250. The others, ranging down to $100, go to F. E. Skinner, Sealy, Texas; H. B. Sherman, Pasadena, Cal.; A. M. Rheinhardt, Hanford, Cal., and J. M. Silverthorn.

The total assessed valuation of the railroads in Montana, as reported by the State Board of Equalization, in 1901, was $15,485,671. In 1902, on an increased mileage of 144 miles, the total assessed valuation was $32,036,565; or $10,229 per mile, as against $5,183 per mile, in 1901. This is on a basis of main track mileage; sidings, to the extent of 512 miles, were assessed in 1902 and not in 1901, and helped to bring up the total.

The State Railroad Commissioners of Minnesota, replying to an order of the Legislature, declare that local passenger fares in Minnesota, 3 cents a mile, are not too high. The report points out that comparisons with roads in more thickly settled eastern States are not fair because of the difference in the density of traffic. Moreover, the Minnesota railroads grant deductions from the 3-cent rate by means of mileage books, excursion rates, etc.

Press despatches from Omaha state that the Union Pacific, after protracted negotiations, has made increases of from 12 to 15 per cent. in the pay of conductors and brakemen. This appears to be about the same arrangement that was made by the Southwestern roads. It is stated that passenger conductors will now get about $140 a month; passenger brakemen, $75; freight conductors, $125 to $150, and freight brakemen two-thirds of their conductors' rate.

The Secretary of the Railroad Department of the Young Men's Christian Association announces that at the Railroad Y. M. C. A. Conference to be held in Topeka, Kan., beginning April 30, there will be present a number of prominent railroad men, including Mr. Busch, of Copenhagen, a representative of the government of Denmark. The management also expects Miss Helen Miller Gould and Rev. J. Wilbur Chapman, of New York; and it is said in the newspapers that President Roosevelt is going to be present.

In the Federal Court at St. Louis, Judge Wood has made permanent an injunction granted last October restraining D. Wasserman from buying or selling World's Fair excursion tickets issued as non-transferable. It appears that the broker had made a defense on the lines of that which was successfully made by the brokers at Buffalo a year or two ago, when the railroads were turned out of court because they were held to be lawbreakers themselves. The judge held that they were violating the anti-trust law and therefore did not come into court with clean hands. The St. Louis court, however, according to the despatches, holds that the Western Passenger Association is a lawful organization, in nowise conflicting with any State or Federal statute.

Pig Iron in Canada in 1902.

The production of pig iron in Canada in 1902, as reported to the American Iron & Steel Association, shows an increase of 74,581 gross tons, or over 30 per cent., as compared with 1901. The total production in 1902 amounted to 319,557 gross tons, against 244,976 tons in 1901 and 86,090 tons in 1900. Of the total production in 1902, 302,712 tons were made with coke and 16,845 tons with charcoal. Basic pig iron amounted to 107,315 tons, and Bessemer to about 9,000 tons. Spiegeleisen and ferromanganese have not been made since 1899.

The following table gives the total production of all kinds of pig iron (including spiegeleisen and ferromanganese) in Canada from 1894 to 1902.

Years.	Gross tons.	Years.	Gross tons.	Years.	Gross tons.
1894	44,791	1897	53,796	1900	86,090
1895	37,829	1898	68,755	1901	244,976
1896	60,030	1899	94,077	1902	319,557

—*The Bulletin.*

Electric Railroads in London.

In connection with the announcement of a Royal Commission to investigate the whole question of the London underground railroad system, the *London Telegraph* gives the following classification of the existing electric railroads, and projects.

Open for Traffic.—Central London, Shepherd's Bush to Bank; City & South London, Clapham Common to Angel, Islington; Waterloo & City, London & Southwestern terminus to Bank.

Work in Progress.—Baker Street & Waterloo, Paddington to London & Southwestern terminus, thence to St. George's Circus; Great Northern & City, Finsbury Park to Bank.

Authorized.—Brompton & Piccadilly Circus, Acts 1897, 1899 and 1902; Charing Cross, Euston, Highgate & Hampstead, Acts 1893, 1900 and 1902; Great Northern & Strand, Acts 1899 and 1902; Great Northern (No. 2), Act of 1902; City & Brixton, Act of 1897; Metropolitan District, Act of 1897; Northwest London, Act of 1899.

Projected.—Extension of City & South London; Paddington, Victoria & Kennington; Northeast London; Clapham Junction & Marble Arch; extension of Northwest London; extension of Central London, and the extension of the District Ry. to Acton Green.

Complying With the Senate's Wish.

The Interstate Commerce Commission has sent to the United States Senate the report which it has made in response to a resolution of the Senate asking for a statement showing the character and par value of all stocks, bonds, income bonds, and other securities issued or authorized to be issued by each railroad company, as of June 30, 1900; also the rate of interest or dividends paid thereon during the year. The report of the Commission contains two tables. The first gives the total par value and market value of railroad securities for the 10 statistical groups and for the whole United States. This table also shows the par value and market value of the capital stock and also the par value and market value of the funded debt. For the United States the total par value of securities is stated to be $11,724,035,829, and the market value of such securities is given as $8,351,103,523. The capital stock is stated to be, par value $6,021,364,502, and market value $3,250,144,596. The par value of the funded debt is stated to be $5,702,671,327, and the market value $5,100,958,927. Some exceptions to the statement of market value are set forth in foot notes at the bottom of the table.

The second table presents the main facts more in detail by classifying capital stock as common, first preferred and second preferred; and funded debt as mortgage bonds, miscellaneous obligations, income bonds, and equipment trust obligations. The term "miscellaneous obligations" is intended to cover obligations that are liens on some species of property specifically described, as distinct from obligations which are general liens on the road and its franchises.

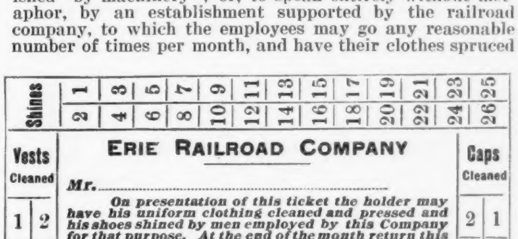
The Commission calls attention to the great amount of time and labor which has necessarily been expended in the effort to comply with the resolution, and states that the greater part of the work has been done by the regular clerical force of the Commission in addition to their ordinary duties. That the work is wholly useless, the Commissioners are too polite to say.

Thomas S. Clarkson Memorial School of Technology.

Mr. Frederic William Sanders has been appointed to the Chair of Economics, Sociology and Modern Languages. Mr. Merrill Van G. Smith has been appointed Professor of Mechanical Engineering.

Good As an Increase in Pay.

Since the first of February, the train and station men in the passenger department of the Erie Road at Jersey City, and on trains running to and from that point, have been having their uniforms cleaned and their shoes polished "by machinery"; or, to speak entirely without metaphor, by an establishment supported by the railroad company, to which the employees may go any reasonable number of times per month, and have their clothes spruced



Shines 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

Vests Cleaned 1 2 3 4 5 6

ERIE RAILROAD COMPANY

Mr. ....

On presentation of this ticket the holder may have his uniform clothing cleaned and pressed and his shoes shined by men employed by this Company for that purpose. At the end of the month return this ticket PROMPTLY to the undersigned and a new one will be issued.

Month of *190*

No. 896 .... *Supt.*

Caps Cleaned 1 2 3 4 5 6

Trousers Cleaned and Pressed 1 2 3 4 5 6 7 8 9 10 11 12

Coats Cleaned and Pressed 1 2 3 4 5 6

up by expert workmen without expense. Each man entitled to the privileges of this "bureau" is provided on the first of each month with a ticket, a sample of which is shown above. The shoes can be polished 25 times; the trousers can be cleaned and pressed 12 times and the other articles of apparel six times in a month. Superintendent W. L. Derr, in announcing the establishment of this department, informed the men by circular that they would be expected to take advantage of the privilege and to "be very particular of their personal appearance." That word "very" is particularly commendable: the only satisfactory standard is the highest. We shall expect now to see 99 per cent. of the Erie's men present a faultless appearance.

New Public Buildings at Washington, D. C.

In addition to the new Union railroad station at Washington, mentioned last week, Congress authorized a new building for the National Museum to cost not more than $3,500,000, and appropriated $255,000 toward it. To begin work on the new building for the Agricultural Department, $250,000 was appropriated. A Hall of Records to be located west of the State, War and Navy building and to cost not more than $2,000,000 was authorized; the limit of cost of the Municipal building for the District

of Columbia was increased from $1,500,000 to $2,000,000, and a number of hospitals, additions to Government buildings and smaller projects were provided for. The grand total for buildings authorized or increased in cost at this session, including the Union station, but not including the Army War College, is $16,711,000, of which $2,561,000 is appropriated for the next fiscal year. The departmental buildings will be located in accordance with the recommendations of the Park Commission which reported to the Senate last year.

For the new office building for the House of Representatives, to cost $3,100,000, a Commission consisting of Representatives Cannon, Hepburn and Richardson has been appointed to select a site, which is to be one of four squares immediately south of the U. S. Capitol grounds, and a number of Government engineers, including Mr. Bernard R. Green, Superintendent of the building of the Library of Congress, and Capt. Sewell, Corps of Engineers, U. S. Army, are being consulted in the matter.

New York Branch of Civic Federation.

The Civic Federation of New York City was organized March 3, as a branch of the National Civic Federation, in pursuance of the policy adopted at the last meeting of the national society, of establishing local federations. Lewis Nixon was elected permanent chairman, and F. D. Underwood, W. C. Brown, W. H. Baldwin, Jr., and S. R. Callaway were appointed, among others, to serve on the "employers'" part of the committee.

Manila Street Railroad Franchises.

A syndicate consisting of Westinghouse, Church, Kerr & Co., J. G. White, of New York, and Charles Swift, of Detroit, made the only bid for the electric street railroad, and the light and power franchises of Manila, on March 5. The syndicate offered 2½ per cent. of the gross receipts of both franchises for 50 years.

Interstate Commerce Commission.

The Interstate Commerce Commission has sent to the United States Senate its report in compliance with a resolution of the Senate directing the Commission to investigate differences between import and domestic rates. The report contains ten tables showing the domestic and import rates from New York and other North Atlantic ports, Montreal to Newport News, inclusive, and two other tables show the customs duties on numerous articles. The report also contains statements in regard to import and domestic rates from New Orleans and other Gulf ports. The testimony taken indicates that from January to July, 1902, the published rates from ports of entry to interior destinations on traffic imported through North Atlantic ports were without exception maintained, and that the published rates on domestic traffic from those ports had also been observed during that period. It was admitted, however, that departures from published rates were formerly not infrequent. Cement, salt, iron ore and salt cake are articles used to illustrate wide differences between the import and domestic rates from ports of entry to interior destinations which nearly or fully equal or exceed the amount of the customs duty. The Commission has found it difficult to compare the duties with the differences in rates because the duties are based wholly or partly on value, while the rates are based on weight.

Disastrous Oil Explosion at Olean, N. Y.

On the evening of March 9, an explosion of oil or gasoline tanks in a freight train of the Erie Railroad at Olean, N. Y., spread burning oil among a great crowd of bystanders, and 15 or more persons were fatally injured and many others less severely. A train had broken in two and this was followed by a slight collision. One of the cars was also heated, and perhaps afire, from a hot journal, and it appears that the explosion was caused either by the collision or the hot box. The victims were chiefly boys and other curious persons who had ventured too near the burning cars.

One Effect of Elkins Law.

The United States Supreme Court on March 9 rendered its first opinion in an interstate commerce case in which the Elkins act, passed at the last session of Congress, was dealt with. The case was that of the Missouri Pacific against the United States, involving a question of discrimination between places. It was brought at the instance of the Interstate Commerce Commission, but without any previous proceedings on the part of the commission. The railroad company filed a demurrer challenging the regularity of the proceeding, but the lower courts held the proceeding to be regular, and decided the case in favor of the Government. These decisions are now reversed. Justice White says that by the terms of the old law, under which the case was tried, the proceeding would not have been regular, but that under the Elkins law it would be. The court, therefore, sent the case back for a new trial under the Elkins act. The bill originally was filed in 1893, the allegation being that higher charges were made for carrying freight over the Missouri Pacific from St. Louis to Wichita than for carrying it over the same line from St. Louis to Omaha, notwithstanding the distance is in favor of Wichita. Before the trial the Interstate Commerce Commission had not given a hearing, and therefore there had been no finding of fact. Under the law then there was no authority to bring suit as it was brought, but the third section of the Elkins act grants authority for trial on petition, and explicitly authorizes proceedings at the request of the Interstate Commerce Commission.

Justices Harlan and Brewer united in a dissenting opinion, which was delivered by Justice Brewer, who took the position that the Supreme Court could not review the decree of the court below unless it be final, whereas this case was brought up on a demurrer. He thought the decree of the Court of Appeals should be reversed, but with directions to the lower court to dismiss the bill. The stipulation in the case entered into by counsel on both sides was that the court should pass on certain modes of procedure, and the decision of the court was therefore an overturning of the previous rulings of the court in that regard. Further, the dissenters thought the Interstate Commerce act was sufficient of itself for the punishment of all its violations and did not depend on the Elkins act. This was an independent suit, said Justice Brewer, instituted by the Government to enforce the duty cast upon carriers of interstate commerce, and the right of the Government to maintain such a suit did not depend upon the request of any individual or board. The demurrer filed by the railroad company, he said, admitted that the charges for shipments for freight between St. Louis and Wichita, were "unreasonable, excessive, exorbitant and unjust in and of themselves," which was surely a disregard of what was at common law a plain and recognized duty of the carrier. But beyond this the Interstate Commerce law forbids unjust discrimination, and such discrimination was also clearly and fully set forth in the bill. Could it be that the Government was powerless to compel the carriers to conform to their statutory duties?

LOCOMOTIVE BUILDING.

The El Paso & Southwestern is having two locomotives built at the Baldwin Works.

The Tennessee Central is having six locomotives built at the Rhode Island Works of the American Locomotive Co.

The Illinois Central has ordered 35 consolidation, 10 switching and five passenger locomotives from the Rogers Locomotive Works.

The Sydney & Louisburg (Sydney, N. S.,) has ordered two simple double end consolidation locomotives from the American Locomotive Co. Total weight, 178,000 lbs.; cylinders, 21 x 26 in.; 50-in. driving wheels, wide firebox 76 in. long and 70 in. wide; tank capacity, 4,000 gallons; coal capacity, eight tons. Boiler diameter, 72 in., with a working pressure of 200 lbs. per sq. in., containing 368 Franklinite tubes 13 ft. x 11 in. long. The special equipment includes: Leach pneumatic sanders, Westinghouse air-brakes, Crosby pop valves, Nathan sight feed lubricators, Hancock inspirators, and Schoenberger steel in fire-box. Address C. E. Slayton, Glace Bay, C. B., Canada.

The Canadian Pacific has ordered 20 two-cylinder Pittsburg system compound, 10-wheel freight and passenger locomotives from the Saxon Engine Works, Chemnitz, Germany, for September delivery. The locomotives will weigh 169,000 lbs., with 128,000 lbs. on the drivers, and have 22 and 33 x 26 in. cylinders, 63 in. drivers and radial stay extended wagon top boilers, with a working steam pressure of 210 lbs.; heating surface, 2,421 sq. ft.; 328 Swedish steel tubes, 2 in. in diameter and 13 ft. 2⅛ in. long; steel fire-box, 9 ft. 6 in. long and 3 ft. 5⅞ in. wide; grate area, 33.2 sq. ft.; tank capacity, 5,000 gallons of water; coal capacity, 10 tons; and 10 in. steel channel tender frames. The special equipment will include: "Little Giant" bell ringers, Franklin Mfg. Co.'s magnesia boiler lagging, Simplex brake-beams, M. C. B. standard brake-shoes, Washburn flexible pilot couplers, and M. C. B. Tower couplers on tenders, Edwards electric headlights, Hancock injectors, Damascus nickel bronze journal bearings, U. S. piston and valve rod packings, World Brand (Thos. McAvity & Sons, St. John, N. B.) safety valves, Leach sanding devices, Michigan sight-feed lubricators, Saxon Engine Works' springs, Star steam gages, Gold steam heat equipment, and Krupp driving, truck and tender wheel tires. Other specialties are: Star whistles and Taylor iron rivets and stays.

The Mexican Central has ordered 25 simple consolidation, eight simple mogul and two simple six-wheel switching locomotives from the American Locomotive Co. The consolidation locomotives will weigh 187,000 lbs., with 165,000 lbs. on the drivers, and have 21 x 26 in. cylinders, 48 in. drivers and straight top radial stay boilers, with a working steam pressure of 200 lbs.; 350 lap welded charcoal iron tubes, 2 in. in diameter and 14 ft. long; wide fire-box, 96 in. long and 66 in. wide; grate area, 44 sq. ft.; tank capacity, 6,000 gallons of water and 12 tons of coal. The moguls will weigh 154,000 lbs., with 132,000 lbs. on the drivers, and have 20 x 26 in. cylinders, 56 in. drivers and straight top boilers, with a working steam pressure of 200 lbs.; 320 lap welded charcoal iron tubes, 2 in. in diameter and 13 ft. long; wide fire-box, 96 in. long and 66 in. wide; grate area, 44 sq. ft.; tank capacity, 6,000 gallons of water and 12 tons of coal. The switching locomotives will weigh 126,000 lbs., and have 19 x 24 in. cylinders, 50 in. drivers and Belpaire boilers, with a working steam pressure of 180 lbs.; 272 lap welded charcoal iron tubes, 2 in. in diameter, 11 ft. 7$^{11}/_{16}$ in. long; fire-box, 90 in. long and 38¾ in. wide; grate area, 23.6 sq. ft.; tank capacity, 3,900 gallons of water and six tons of coal. The special equipment for all will include: Westinghouse air-brakes, Taylor iron axles for switching locomotives, Keasbey & Mattison sectional magnesia boiler lagging for consolidation and mogul locomotives, and John's fire felt boiler lagging for switching locomotives, National-Hollow brake-beams, Christie brake-shoes for consolidation and mogul locomotives, Tower couplers, Friedman non-lifting injectors, Phosphor bronze journal bearings, Smith's metallic piston rod packings for consolidation and mogul locomotives, and Mexican Central standard piston rod packings for switching locomotives; H. W. John's fibrous valve rod packings for consolidation and mogul locomotives, Crosby safety valves, Leach pneumatic sanding devices for consolidation and mogul locomotives, Michigan improved sight-feed lubricators, Pittsburg Steel Spring Co.'s springs, Crosby steam gages, and Johnson staybolts, Low Moor iron. Other specialties for consolidation and mogul locomotives are: Le Chatelier water brakes, Johnstone's blow-off cocks, Westinghouse friction draft gears and Stannard & White engineers' seats.

CAR BUILDING.

The Norfolk & Southern is in the market for 25 flat and 25 box cars.

The Pere Marquette has ordered one private car from the American Car & Foundry Co.

The Jalapa & Cordoba has ordered three coaches from the American Car & Foundry Co.

The New Union Sand Co. has ordered 50 side dump cars from the American Car & Foundry Co.

The Carolina & Northwestern has ordered five ballast cars from the American Car & Foundry Co.

The Chicago, Milwaukee & St. Paul is reported to be going to build some freight cars at its shops.

The Miami & Erie Canal Co. has ordered 12 center dump cars from the American Car & Foundry Co.

The Great Western of Colorado has ordered 50 side dump cars from the American Car & Foundry Co.

The Bismarck, Washburn & Great Falls has ordered 25 gondola cars from the American Car & Foundry Co.

The Chicago, Burlington & Quincy has ordered 2,000 side dump coal cars from the American Car & Foundry Co.

The Markle Mfg. Co. (Philadelphia) has ordered from 250 to 500 gondola cars from the American Car & Foundry Co.

The Vera Cruz & Pacific has ordered 70 box, 50 stock, 30 flat and 25 coal cars from the American Car & Foundry Co.

The Chicago & Eastern Illinois has ordered 1,000 freight cars and from 25 to 35 cabooses from the American Car & Foundry Co.

The Grand Trunk has ordered 500 coal and 500 box cars from the American Car & Foundry Co., and 500 steel cars from the Pressed Steel Car Co.

The Metropolitan West Side Elevated Railroad of Chicago has ordered 44 motor, 12 passenger, and 20 controller cars from the American Car & Foundry Co.

The Mexican Central is reported to have ordered 1,050 cars from the Pullman Company. The special equipment includes: Commonwealth steel body and truck bolsters.

The Brockville, Westport & Sault Ste. Marie is in the market for passenger equipment, and eight box cars of 50,000 lbs. capacity, and three stock cars of 40,000 lbs. capacity.

The St. Joseph & Grand Island has ordered 200 box cars of 80,000 lbs. capacity from the Western Steel Car & Foundry Co., to be built of steel, with pressed steel underframes. The special equipment includes: Commonwealth steel body and truck bolsters, Tower couplers, Miner draft rigging and McCord journal boxes.

The Kansas City Southern, as reported in our issue of Feb. 20, has ordered 250 box cars of 60,000 lbs. capacity from the American Car & Foundry Co., for April delivery. The cars will weigh 31,000 lbs., and measure 36 ft. long, 8 ft. 6 in. wide and 8 ft. 1 in. high, all inside measurements. The special equipment includes: More-Jones brasses, Kelso malleable couplers, Dunham door fastenings, Miner draft rigging, M. C. B. Symington journal boxes and lids, Hutchins roofs and Scott springs.

BRIDGE BUILDING.

AKRON, OHIO.—The City Council and County Commissioners will build a new bridge over the Cuyahoga River at Cuyahoga street.

AUBURN, PA.—Plans have been accepted and bids will soon be advertised for the new State bridge over the Schuylkill River.

BEATRICE, NEB.—Bids will be received until noon, March 31, for all bridge work to be done in Gage County during the year. J. R. Plastes, County Clerk.

BOSTON, MASS.—The following bids were received for the draw for the Wellington bridge over the Mystic River between Somerville and Medford: Canton Bridge Company, $19,600; Penn Bridge Company, $18,600; Eastern Bridge & Structural Company, $18,000; United Construction Company, $18,000; Berlin Construction Company, $17,650; King Bridge Company, of Cleveland, $17,550; New England Structural Company, $17,500; Boston Bridge Works, $16,950.

BUCKLEY, WASH.—Bids will be received March 19 by the County Commissioners for a bridge over White River to join Pierce and King Counties at this place.

CARLINVILLE, ILL.—Bids will soon be wanted for a 126 ft. steel bridge to be built on Button street by the city and township. H. M. Winton.

CHICAGO, ILL.—Designs for a $35,000 bridge to be built in Jackson Park will be received by the South Park Commissioners until March 18. E. G. Shumway, Secretary.

CONGO, W. VA.—The Wellsville Bridge Co., Congo, W. Va., has been incorporated with $5,000 capital to build a toll bridge. Jas. H. Newell, Chester, W. Va.; Perle Howard, Cargo, W. Va.; Frank J. Wells, Wellsville, Ohio, and others are named as incorporators.

CUMBERLAND, MD.—Allegheny County Commissioners will construct a steel and concrete bridge over Flintstone Creek.

DENVER, COLO.—McCreary & Willard, railroad contractors of Spokane, Wash., have a contract to build bridges on the Denver & Rio Grande, at a cost of $35,000. The main structures are those over the Grand River at Grand Junction and at Glenwood; also at Buena Vista.

FORT MYERS, FLA.—The Atlantic Coast Line R. R. are to let a contract for a draw bridge at this place over the Caloosahatchee River. F. T. Tutwiler, Assistant Chief Engineer, Savannah, Ga.

FRONT ROYAL, VA.—Warren County will construct a steel bridge across the Shenandoah at Carsons Ford. Length, 540 ft.; approaches, 150 ft. each; cost, $15,000. Address County Clerk.

HASSELL, N. C.—Bids are wanted on April 6 by W. C. Manning, Clerk Martin County, Williamston, N. C., for a steel bridge over Conoho Creek, four miles from this place.

KNOXVILLE, TENN.—The Louisville & Nashville is reported to have prepared plans for a $96,000 viaduct on Church avenue over its terminal tracks. The city is asked to meet about a third of the cost.

LINCOLN, NEB.—Press despatches announce the washout of several bridges on the main lines of the Burlington and the Union Pacific in this vicinity.

MENA, ARK.—Bridge bonds to the amount of $15,000 will be sold on March 21. J. H. Hamilton, Secretary.

MILWAUKEE, WIS.—New bids are wanted for the proposed bridge over the Menomenee Canal at Muskego avenue.

NORWALK, OHIO.—Engineers are surveying for a new steel bridge to be built by the city, the Wheeling & Lake Erie, and the Lake Shore Electric.

ONEIDA, N. Y.—The Common Council recently adopted a resolution authorizing the Board of Public Works to construct a bridge over the canal feeder at the foot of Furnace avenue, without advertising for further proposals.

ORTING, WASH.—A bridge is to be built by private subscription over the Puyallup River at the junction known as Walter's mill. John Whitley, Superintendent.

PATERSON, N. J.—The Board of Freeholders is considering building a bridge on Spruce street, between Market street and the Passaic Falls bridge.

RICHMOND, VA.—The Virginia Passenger & Power Co. is expected soon to ask bids for its new bridge over the James River to Manchester. Calvin Whiteley, Jr., Chief Engineer, 1222 Carey street.

SHACK'S MILLS, PA.—The Pennsylvania Railroad's new stone bridge over the Susquehanna River, 18 miles below Harrisburg, will be 2,200 ft. long and will have 28 piers, 37 ft. 8 in. above low water mark. There will be 7 ft. of masonry over each arch.

SKOWHEGAN, ME.—A $15,000 bridge is to be built over the Kennebec River near Kennebec street.

SPOKANE, WASH.—Improvements to cost $24,000 have been ordered for the Monroe street bridge, including a

new 100 ft. steel plate girder span, and 154 ft. of steel work to replace the south approach.

UNIONTOWN, PA.—Bids will soon be asked for an inter-county bridge over Jacob's Creek in Upper Tyrone Township.

WASHINGTON, D. C.—An appropriation of $48,000 has been made for work on the Connecticut avenue viaduct, and the Commissioners are authorized to contract for completing the same at a maximum cost of $788,000.

YORK, PA.—A new electric railroad will build a bridge over the Western Maryland & Pennsylvania tracks.

Other Structures.

AVONMORE, PA.—The Avonmore Construction Co. has been organized and a plant will be built equipped for furnishing boilers, plate iron and structural work, steel plants, foundries, blast furnaces and rolling mills. J. Harrison Orwig, Manager.

BURLINGTON, IOWA.—The Burlington is said to be preparing plans for shops to be built at this place.

CHATTANOOGA, TENN.—It is reported that the Chattanooga Machinery Co. will erect machine shops and make improvements to cost $30,000, for which contracts will soon be awarded.

DANVILLE, ILL.—The Big Four has appropriated $14,000 for a new freight depot to be built on the site of the present one.

FULTONHAM, OHIO.—The Zanesville & Western will probably erect an eight-stall roundhouse at this place.

HARRISON, N. J.—The general contract for building the International Steam Pump Company's plant has been let to V. J. Hedden & Sons Co., of Newark.

HELENA, MONT.—The Northern Pacific freight warehouse and several loaded cars were burned on March 8, causing a loss of $50,000.

HOCHELAGA, QUEBEC.—The Canadian Pacific is asking bids for three more buildings in connection with the Hochelaga shops.

KANSAS CITY, MO.—The Santa Fe freight depot and 85 box cars were recently destroyed by fire at a loss of $200,000.

KNOXVILLE, TENN.—Plans have been submitted for a new passenger station to be built by the Louisville & Nashville.

NEWARK, N. J.—Press reports announce the proposed erection of a $2,000,000 hoisting machine plant to be conducted by the Lidgerwood Manufacturing Co., of Brooklyn.

NORWALK, OHIO.—It is reported that the Norwalk Steel & Iron Co. will build a new steel casting plant during the coming year.

SAN BERNARDINO, CAL.—The Southern Pacific is said to have appropriated $100,000 for a new passenger station and freight depot.

SEATTLE, WASH.—The Washington Iron Works will build a new machine shop to cost about $100,000.

TALLADEGA, ALA.—It is reported that the Louisville & Nashville contemplates building a $10,000 passenger station and enlarging its freight house.

WACO, TEXAS.—It is said a new passenger station will be built by the St. Louis Southwestern.

WASHINGTON, PA.—G. M. Davis and H. G. Manning are named as the promoters of the Washington Machinery Co., a new industry which will erect a foundry at this place.

MEETINGS AND ANNOUNCEMENTS.

(For dates of conventions and regular meetings of railroad associations and engineering societies see advertising page xvi.)

Canadian Society of Civil Engineers.

At the meeting Thursday, March 12, a paper was read by Mr. J. G. G. Kerry on "Some Theories Upon Railroad Location." It was illustrated by lantern projections.

Rocky Mountain Railway Club.

At the meeting on Jan. 17 there was a discussion on the "Relation of the Effects of Heavy Wheel Loads on Track to the Reduced Cost of Moving Traffic." The discussion was opened by Mr. Hugh Wilson, who read a paper on the subject at the previous meeting. E. E. Whitted, General Solicitor of the Colorado & Southern, read a paper on "Personal Injury Claims Against Railroads and the Relation of the Employee to Them."

Western Railway Club.

The March meeting will be held at 2 o'clock on the 17th in the Auditorium Hotel, Chicago. The subjects will be "Equated Tonnage Ratings" by M. H. Wickhorst, Engineer of Tests, Chicago, Burlington & Quincy; and "Paint" by Mr. Houston Lowe, Vice-President, Lowe Bros. Co., Dayton, Ohio. The latter, a carefully prepared paper, was postponed from the February meeting through lack of time to do it justice in the discussion.

Central Railway Club.

The next regular meeting of the Club will be held at the Hotel Iroquois, Buffalo, N. Y., on March 13, at 2 p.m. Discussion will be continued on the paper read in January by Dr. Charles E. Lucke, of Columbia University, New York, on "The Indicator as an Engineer's Instrument."

Recommendations as to changes in the Rules of Interchange, to the Arbitration Committee of the M. C. B. Association, will be reported by a special committee, consisting of G. N. Dow, M. C. B. of the L. S. & M. S. R. R., Chairman; H. M. Carson, S. M. P., Pennsylvania Railroad; James Macbeth, M. C. B., N. Y. C. & H. R. R.

Car Foremen's Association of Chicago.

The regular meeting was held March 11, the following programme being discussed:

1. Report of committee on revision of M. C. B. rules.
2. Case in dispute: A receives B's car from C, badly damaged, with D's defect cards on, covering part of defects. Car not fit to load but safe to handle. Car belongs home via A's line. Car not having home route cards on, how should A handle it?
3. Is a road justified in refusing its own car, which has been wrecked by a connecting line but is safe to handle, the delivering line offering to furnish defect cards for all defects.
4. Discussion of M. C. B. rules.

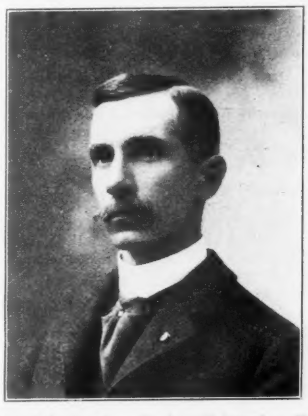
PERSONAL.

—Mr. R. J. Gatling, inventor of the Gatling gun, died in New York, February 26, at the age of 84.

—Mr. William Swanston, who for a number of years was Master Mechanic of the Pennsylvania Lines at Indianapolis, Ind., died March 4. He was born at Glasgow, Scotland, in 1827, and was educated at Mechanics' Institute in that city. In 1850 he went to Cincinnati and began his railroad service as a machinist for the Little Miami. For five years he was with the Cincinnati, Sandusky & Cleveland as Master Mechanic, but later returned to the Little Miami as Assistant Master Mechanic. In November, 1884, Mr. Swanston was appointed Master Mechanic of the Pennsylvania Lines, which position he held until he was retired in 1901.

—Mr. Walter A. Scott, General Manager of the Chicago, St. Paul, Minneapolis & Omaha, died March 4, after an illness of several months. Mr. Scott was born in New York city in 1840, and from 1858 to 1868 was with the Chicago, Iowa & Nebraska in subordinate positions. In the latter year he was appointed Foreman of shops of the Chicago & North Western, and from 1875 to 1885 was Master Mechanic of the same road. In 1885 he was appointed Assistant Superintendent of Machinery and Motive Power, and in April, 1887, he was transferred to the Superintendency of the Madison Division. Mr. Scott discharged these duties for a few months, at the end of which time he was appointed General Superintendent of the Chicago, St. Paul, Minneapolis & Omaha. In 1896 he became General Manager of this road, which position he held up to the time of his death. Mr. Scott was, first of all, a man of the strictest intellectual honesty. He had no patience with moral delinquencies or moral cowardice; but his long-continued ill health probably intensified his rather pessimistic temperament. His advancement in railroading from the lowest position to one of considerable prominence was not regarded by him in the light of good fortune, although perhaps an achievement to be somewhat proud of. He often expressed the feeling that the happiest man is he who is content to go along in his natural sphere undisturbed by a desire for anything more than comes through the law of gravitation.

—Mr. M. K. Barnum, who lately succeeded Mr. Wilson as Superintendent of Motive Power of the Chicago, Rock Island & Pacific, is 42 years old. He began his railroad service as a special apprentice in the shops of the New York, Lake Erie & Western at Susquehanna, and until 1889 he held various subordinate positions. In that year he was appointed Assistant Master Mechanic of the Atchison, Topeka & Santa Fe, but resigned a year later to go to the Union Pacific as Superintendent of shops at Cheyenne. Then for seven years he was district foreman, and in 1898 was appointed Master Mechanic of the Nebraska Division. Mr. Barnum left this road in December last to become Assistant Mechanical Superintendent of the Southern Railway, but later resigned to go to the Rock Island, as above.



—Mr. Thomas Tait, Manager of Transportation of the Canadian Pacific Railway, has been appointed Chairman of the Commissioners of Railways of the Colony of Victoria, and will sail for Melbourne on May 1. The appointment is for four years with privilege of renewal. In this position Mr. Tait will be the actual working head of the Victorian Railways, the office being like that which Mr. Eddy filled with ability and distinction for the railroads of New South Wales. At the bottom of this appointment lies the fact that the Victorian Railways are not paying and the Government wishes to introduce American methods of management. Mr. Tait takes with him the respect and the cordial good wishes of the Canadian Pacific management and staff, and of a great many railroad officers in the United States. Within the last half-dozen years he has risen fast in reputation as an able, zealous and studious officer, a railroad man of the best school. This reputation rests on years of inconspicuous but solid work. Mr. Tait was born at Melbourne, Quebec, in 1864, and his railroad career dates from 1880, when he began as a clerk in the audit office of the Grand Trunk at Montreal. In 1881 he was appointed clerk to the Assistant to the President, thence he went to the Solicitor's office at Belleville, Ont., and after that to a clerkship in the General Manager's office at Montreal. In 1882 Mr. Tait went to the Canadian Pacific to become Private Secretary to the Vice-President and General Manager. For two years (1887-1889) he was Assistant Superintendent at Moose Jaw and subsequently became Superintendent of the Ontario Division at Toronto, General Superintendent of the Ontario & Quebec Division, Assistant General Manager, Manager of Eastern Lines and finally in May, 1901, Manager of all the Canadian Pacific Lines.

The Victorian railroads aggregate between 3,000 and 3,500 miles. The Chairman acts under the Minister of Railways, but the other two commissioners are working departmental officers and when there is a difference of opinion between them the opinion of the Chairman prevails. The last annual report which we have at hand shows that the Government railroads (year ending June 30, 1901,) earned a total revenue of £3,338,000, and the net receipts were £1,353,000. This sum is equal to 3.37 per cent. of the total capital cost of the railroads and to 3.64 per cent. of the total loan moneys expended. The Government owns 544 locomotives, 1,179 passenger vehicles, and about 10,000 freight and miscellaneous cars. The number of employees is given as 11,956, and the train mileage as 11 millions.

—Mr. A. C. Bird, Third Vice-President of the Chicago, Milwaukee & St. Paul, who has just become Traffic Director of the Gould Lines, is 60 years old and is a native of Illinois, having been born near Pittsfield, Pike County, in 1843. His railroad career dates from 1865, when he began as a night watchman at Pana, Ill., for the St. Louis, Alton & Terre Haute. He was later called to the general office at St. Louis. In April, 1872, he was appointed Chief Clerk of the Freight Department of the St. Louis, Kansas City & Northern, now a part of the Wabash System, and in 1874 he became its General Freight Agent. In 1879 he was made General Freight Agent of the Wabash, St. Louis & Pacific, and subsequently Superintendent of Freight Traffic. Mr. Bird has been connected with the St. Paul System for a number of years, beginning in 1883 as General Freight Agent. Six years later he was made Freight Traffic Manager, and in 1895 General Traffic Manager. In 1899 he was elected to the Third Vice-Presidency, which position he has held until now. Mr. Bird's position is a newly created one and his work involves the general charge of traffic on all the so-called Gould lines. These roads are the Missouri Pacific, Wabash, Wheeling & Lake Erie, Ann Arbor, Western Maryland (including the West Virginia Central & Pittsburgh), International & Great Northern, Texas & Pacific, Denver & Rio Grande, Rio Grande Western and the Rio Grande Southern.

ELECTIONS AND APPOINTMENTS.

Alabama State R. R. Commission.—On March 1, Wiley C. Tunstall was reappointed Commissioner, and William T. Sanders was appointed Commissioner, to succeed A. E. Caffee, of Birmingham.

Arkansas Southern.—H. C. Brown has been elected Vice-President in charge of transportation, accounts, traffic and maintenance, with headquarters at Ruston, La. C. C. Henderson, General Manager, having resigned, that position is abolished and the duties heretofore performed by the General Manager will be assumed by the Vice-President. W. L. Porterfield has been appointed General Auditor, succeeding R. W. Huie, resigned. J. W. Drayer, Assistant Auditor, has also resigned.

Atchison, Topeka & Santa Fe.—F. H. Manter has been appointed Assistant General Freight Agent, with headquarters in Chicago, Ill., succeeding J. W. Tedford, resigned.

F. H. Manter, heretofore General Agent, has been appointed Assistant General Freight Agent, with headquarters at Chicago, Ill.

Baltimore & Ohio.—William Graham has been appointed Assistant Engineer of Bridges and Buildings of this company, and the Baltimore & Ohio Southwestern, with headquarters at Baltimore, Md.

G. M. Schriver has been appointed Assistant to the President.

Baltimore & Ohio Southwestern.—See Baltimore & Ohio.

Boston & Maine.—C. N. Chevalier has been appointed Purchasing Agent, with headquarters at Boston, succeeding J. A. Farrington, resigned on account of ill health. J. R. Rooks has been appointed Fuel Agent, succeeding Mr. Chevalier.

Canadian Pacific.—After April 1 the main lines and branches between Port Arthur, Pasqua and Estevan will be known as the Central Division, with J. W. Leonard, Winnipeg, as General Superintendent, and the main lines and branches between Portal, Laggan and Kootenay Landing will be known as the Western Division, of which R. R. Jamieson will be General Superintendent, with headquarters at Calgary.

J. H. Manning has been appointed Assistant Superintendent of Rolling Stock, with headquarters at Montreal, Que.

Charleston, Clendennin & Sutton.—W. J. Quantock has been appointed Auditor, with headquarters at Charleston, W. Va.

Chicago Great Western.—C. O. Kalman has been appointed Auditor, succeeding W. B. Bend, resigned. R. O. Barnard has been elected Treasurer, succeeding Mr. Kalman.

Chicago, Indianapolis & Louisville.—B. E. Taylor, heretofore Purchasing Agent, has been appointed Assistant to the President and General Manager, with headquarters at Chicago.

Chihuahua & Pacific.—F. W. Andros, Chief Engineer, with headquarters at Chihuahua, Mex., has resigned.

Coahuila & Pacific.—M. W. Sellers has been appointed General Superintendent, with headquarters at Saltillo, Mex., succeeding J. D. Melville.

Erie.—J. H. Taylor has been appointed Division Superintendent, with headquarters at Bradford, Pa., succeeding C. V. Merrick.

Erie & Western Transportation Company.—E. T. Evans has been elected a Vice-President, with headquarters at Buffalo, and J. E. Payne becomes a Vice-President, with headquarters at Philadelphia. Both these offices have been newly created. J. C. Evans has been appointed to succeed Mr. Evans as Western Manager, and W. Thayer succeeds Mr. Payne as Eastern Manager, effective April 1.

Indiana, Illinois & Iowa.—The jurisdiction of Superintendent H. A. Ziesel, of the Lake Shore & Michigan Southern at Chicago, has been extended over the I., I. & I., and S. M. Brown has been appointed Assistant Superintendent of the Western Division.

Lehigh Valley.—The headquarters of C. C. Huntington, General Storekeeper, will, on March 15, be removed to Packerton, Pa.

Missouri Pacific.—At a meeting of the stockholders held March 10, J. D. Rockefeller, Jr., and J. H. Hyde were elected Directors.

New Jersey & Delaware River.—S. B. Dutcher has been elected President of this newly incorporated company. (See R. R. Construction column.)

Newton & Northwestern.—S. McClure, General Manager, with headquarters at Fraser, Iowa, has resigned.

Pacific Coast.—H. W. Cannon, Chairman of the Board, has been elected President also, succeeding J. D. Farrell, who has become connected with the Great Northern.

Rio Grande Western.—The title of John Hickey has been changed from General Master Mechanic to Master Mechanic.

St. Louis, Iron Mountain & Southern (Missouri Pacific).—K. G. Morley has been appointed Superintendent, with headquarters at Mer Rouge, La., succeeding J. A. Swigart, resigned.

Southern.—The headquarters of S. J. Collins, General Superintendent of the Eastern District, will, on March 15, be removed from Salisbury, N. C., to Greensboro.

Union Pacific.—W. Niland has been appointed Master Mechanic, with headquarters at Cheyenne, Wyo., succeeding A. Stewart.

Wiggins Ferry.—J. J. Baulch has been appointed Traffic Manager; J. E. Gathright has been appointed Auditor, succeeding C. L. Leslie, resigned, and G. Hendricks becomes Treasurer and Cashier, all with headquarters at St. Louis, Mo. F. H. Leslie, Purchasing Agent, has resigned, and that position has been abolished.

RAILROAD CONSTRUCTION.

New Incorporations, Surveys, Etc.

ABBOTTSBURG-SOUTHPORT.—Grading is reported completed for a distance of eight miles south of Whiteville, N. C., on the proposed extension from Abbottsburg southeast via Whiteville and Shallotte to Southport, at the mouth of the Cape Fear River, 65 miles. N. O'Berry, Whiteville, is President.

ATCHISON, TOPEKA & SANTA FE.—It is reported that this company will use part of the old narrow gage California & Nevada line, in its proposed extension from Richmond, Cal., south to Oakland, 15 miles. The California & Nevada, which ran between Bryant and Oakland, went into the hands of a receiver in 1896.

BAKERSFIELD & VENTURA.—A charter has been granted to this company in California, to build from Sunset south to Hueneme, with a branch to Ventura, 60 miles. Surveys are now in progress and work is to be begun shortly. E. Smith, A. N. Sanford and J. W. Swanwick, Los Angeles, are directors.

BIRMINGHAM, COLUMBUS & ST. ANDREWS BAY.—This company has been incorporated in Alabama, to build from Birmingham, south to St. Andrews Bay, Fla. W. O. Butler, W. Miller Gordon, and Donald B. Jones, of Columbus, Ga., are said to be interested.

BRITISH COLUMBIA ROADS.—The Victoria Lumber Company is reported about to build a new line on Vancouver Island, terminating at Oyster Bay, 2½ miles north of Ladysmith. W. Fry is the engineer in charge of the work.

CANADIAN PACIFIC.—It is reported that this company has let the contract for a second track from Rat Portage southeast to Fort William, Ont., 260 miles, to Foley Bros. & Co. Arrangements are now being made to secure men and teams for the work, which will be begun immediately.

CHARLESTON, CLENDENNIN & SUTTON.—Bids will be received until March 20 for grading the proposed extension of this road from Otter, W. Va., in a northerly direction up the Elk River for a distance of 25 miles. Address Arthur Lee, 1517 H street, N. W., Washington, D. C. Plans and maps are on file at the office of C. K. McDermott, Superintendent at Charleston, W. Va.

CYPREMORT & BAYOU TECHE.—Charter has been granted this company in Louisiana to build from Bayou Teche, southeast 40 miles to Cypremort. J. B. Brown is President, and D. P. J. Burguieres, Vice-President and General Manager, both of New Orleans.

DEEPWATER.—It is reported that Boston capitalists have subscribed $4,000,000 to build this road from Robson, W. Va., south to the Bluestone River, about 100 miles, making connections with the Wheeling & Lake Erie and the Chesapeake & Ohio.

DELAWARE & NORTHAMPTON.—This company has been incorporated in New Jersey, with a capital stock of $5,000,000. No plans with regard to the proposed route have as yet been given out. J. R. Hegemen, Chas. P. Jameson, J. P. Northrop, of Trenton, N. J., are incorporators.

GALESBURG & ALEDO INTERURBAN.—Articles of incorporation have been filed by this company in Illinois. The proposed route is from Galesburg northwest via Alexis to Aledo, 25 miles, and to a point on the Mississippi River. L. W. Sanborn is President; J. J. Welsh, Attorney, and C. L. Gerould, Secretary, all of Galesburg, Ill.

GREAT NORTHERN.—This company is reported to have let a contract for building a branch from Columbia Falls, Mont., south to a connection with the Northern Pacific at Jocko, Mont., 70 miles. Work will be begun as soon as the weather permits.

ILLINOIS CENTRAL.—This company has appropriated $1,000,000 for improvement of its road from Fort Dodge east to Iowa Falls, Iowa, 50 miles. The work contemplated consists in straightening curves, and raising the whole track to easier grades. Six concrete culverts will be built, for which contract has been let to W. D. Faus, Webster City, Iowa.

INSULAR (CUBA).—It is reported that this company, which was incorporated in 1902, with a capital stock of $2,500,000, will build four new lines, radiating from Havana, with a total of about 100 miles. These are projected as follows: West from Havana to Mariel, 30 miles; west to Guines, 35 miles, to Managua, and to Congrejeras. Contract for the steel rails for the Mariel branch has already been let to German mills. The new lines will carry passengers and freight, and will be operated by electricity, generated at Havana at the central station of the Havana Electric Ry. Company.

JONESPORT R. R.—An act has been introduced in the Maine Legislature to incorporate a company to build a steam or electric railroad from Jonesport west through the towns of Jonesboro, Addison, Columbia Falls, Columbia and Harrington. The line will connect with the Washington County road.

KENTON & SOUTHERN (ELECTRIC).—The following officers have been elected by this company, which was incorporated in Ohio in January, 1903: J. S. Harshman, Springfield, Ohio, President; R. Emery, Columbus, Ohio, Vice-President. A. E. Appleyard, Boston, is one of the directors. The company contemplates building an electric line from Kenton to Bellefontaine, 25 miles. (Jan. 23, p. 74.)

LINCOLN, SAN FRANCISCO & EASTERN.—Articles of incorporation have been filed by this company in California to build from Lincoln west to Vernon Landing, 15 miles, on the Sacramento River in Sutter County. C. L. Wilson, W. H. Newell, J. R. Webb and Leon Prescott are interested.

MEMPHIS & GULF.—This company has been incorporated in Mississippi, to run from Memphis, Tenn, southeast to Pensacola, Fla., passing through 15 different counties in Mississippi. A. S. Lyman and Chas. H. Blair, New York; Chester H. Pond, Moorehead, Miss., and others, are incorporators.

MEXICAN CENTRAL.—The government of Durango has agreed to pay this road a subsidy of $2,500 per kilometer on such part of the new line from Durango to Gutierrez, as is within the State limits. It is estimated that the subsidy will amount to about $300,000. The State also cedes the right of way, and the land for terminal purposes.

NEW JERSEY & DELAWARE RIVER.—Articles of incorporation have been filed by this company to build from Martin's Creek, on the Belvidere Division of the Pennsylvania, to a point on the Delaware River. Frederick H. Ecker, B. S. Dunn, New York, and Geo. I. Dayton and Howard C. Griffiths, of Jersey City, are interested.

NORFOLK & WESTERN.—Contracts are to be let immediately for building a second track from Welch, W. Va., northwest to Davy, nine miles, and from Matewan northwest to Naugatuck, 18 miles. Chas. S. Churchill, Roanoke, Va., is Chief Engineer.

NORTHEAST TEXAS.—Press reports state that a branch will be built from a point on the Sulphur River, south to Cusseta, Texas, nine miles, and from Redwater to Texarkana, 13 miles. This road was chartered Aug. 13, 1902. J. J. King and G. Munz, Redwater, Texas, may be addressed. (Aug. 29, 1902, p. 682.)

OMAHA, TEKAMAH & NORTHERN (ELECTRIC).—Arrangements for building this new electric line from Sioux City south to Omaha, 100 miles, are reported completed. The proposed route will follow the west bank of the Missouri River, crossing from Sioux City into Nebraska, and running through Tekamah and Decatur, and over the old military road into Omaha.

PENNSYLVANIA.—The contracts for the remaining five of the eight sections of second track between Parkersburg and Columbia, Pa., reported in our issues of Feb. 13 and 27, have been let to W. G. Stahl & Sons, Altoona; John Shields, New York; W. H. Carl & Son, Philadelphia; Moran & Hassatt, Pittsburg, and Chas. A. Sims & Co., Philadelphia. (Feb. 27, p. 160.)

RALEIGH & EASTERN NORTH CAROLINA.—The Legislature of North Carolina has granted a charter to this road. It is proposed to build from Raleigh east via Granville to Washington, 90 miles. J. J. Thomas, C. B. Barbee and J. M. Turner, of Raleigh, N. C., are incorporators. (Jan. 16, p. 56.)

RIO GRANDE & SOUTHWESTERN.—Articles of incorporation have been filed by this company in New Mexico. The proposed route will start from a junction with the Denver & Rio Grande in Rio Arriba County, N. Mex., and extend in a southeasterly direction to Gallinas, N. Mex., in the Apache Indian reservation, approximately 42 miles. E. H. Biggs, Edith, Colo.; Benjamin F. Hill, of Denver, and Frederick E. James, of Lumberton, N. Mex., are interested.

RUSSELLVILLE & DOVER.—This company has been incorporated in Arkansas, to build from Russellville north via Taral to Dover, nine miles, all in Polk County. W. A. Baird is President, and J. B. West, W. B. Berry and W. S. Hoggins, Dover, Ark., are incorporators.

ST. LOUIS & EASTERN (ELECTRIC).—Articles of incorporation have been filed by this company to build an electric line from East St. Louis to St. Elmo, Ill., 70 miles. The proposed route will parallel the Terre Haute & Indianapolis for the entire distance. P. M. Johnson, B. N. Johnson and G. W. Harlan, all of St. Elmo, are directors.

ST. LOUIS, VANDALIA & EASTERN.—Articles of incorporation have been filed by this company in Illinois. It is proposed to build from East St. Louis northeast to Marshall, Clark County, Ill., 150 miles. The names of incorporators are not stated, but the principal office of the road will be at Vandalia, Ill.

SHREVEPORT & RED RIVER VALLEY.—It is reported that contracts will shortly be let for grading the extension of this road from Angola plantation, La., southeast to Baton Rouge, 50 miles.

SOUTH SHORE TRACTION.—This company has been incorporated to build a street surface line from Jamaica, N. Y., east to Brook Haven, 60 miles. Arthur C. Hume, New York; F. D. Shaffer, Hamilton, Ohio; C. H. Davis, Petersburg, Va., and others are interested.

SUGAR PINE.—This company has filed articles of incorporation in California. It is proposed to build from a point near Campbell's Station, in Calaveras County, south to Strawberry Flat, in Tuolumne County, 40 miles. This is undoubtedly the incorporation of the company reported in our issue of March 6, page 176, under the heading of California roads.

TEXARKANA, OKLAHOMA & NORTHWESTERN.—A territorial charter has been granted this company to build a line 1,100 miles long northwest from Texarkana, Texas, through Lincoln, Oklahoma, Logan, Canadian and other counties to Denver, Colo. Capital stock $15,000,000. The incorporators include Territorial Secretary Grimes and other Oklahoma capitalists.

TOLEDO & CHICAGO INTERURBAN.—This company has been incorporated in Ohio, to build an electric line from Pioneer, Ohio, west to Goshen, Ind., 70 miles, connecting with the Indiana Ry. at Goshen, and with the Toledo & Western at Pioneer. The proposed road would complete a line from Toledo to Chicago. J. B. Hanna, Cleveland, is said to be interested.

TRENTON, LAKEWOOD & ATLANTIC TRACTION.—Charter was granted this company on March 5 to build from Trenton, N. J., southeast to Lakewood, 30 miles, where a connection will be made with the Point Pleasant line. Work will be begun at once. Geo. O. Vanderbilt, Princeton, N. J.; Richard N. Page, Trenton; W. B. Mills, of Mount Holly, and others, are incorporators.

UNION PACIFIC.—Contract has been let to the Utah Construction Co. for the improvement work from Morgan east to Echo, Utah, 60 miles. Work will be begun immediately. It is reported that the U. P. will also build a cut-off between Cheyenne and Archer, Wyo., a distance of 10 miles. (March 6, p. 176.)

WASHINGTON & GREAT FALLS ELECTRIC.—It is reported that work on this road will be begun soon. The proposed line is from Washington, D. C., northwest to the Great Falls of the Potomac, 15 miles. The line will run along the Virginia side of the Potomac River, entering Washington over the Aqueduct bridge. Joseph S. Miller, John Graham and Geo. F. Miller, of Huntington, W. Va., are said to be interested.

WESTERN PACIFIC.—The Stockton & Beckwith Pass R. R. has been incorporated in California, under the title of the Western Pacific. The proposed route of the new road is from San Francisco east through Beckwith Pass, in the Sierra Nevadas, to Salt Lake City, approximately 800 miles. David F. Walker, Salt Lake; W. J. Barnett, San Francisco, and others, are among the stockholders. No official information has as yet been given out as to who is projecting the road.

WYOMING ROADS.—Press reports state that the Horseshoe Company, which recently purchased the Cambria mines, is making surveys for the building of a new narrow gage road from New Castle, Wyo., north to the Cambria coal region, 20 miles.

GENERAL RAILROAD NEWS.

ASHTABULA & CONNEAUT.—This electric road, which runs from Ashtabula, Ohio, east to Conneaut and south to Jefferson, 27 miles, has been purchased by J. C. Trask, General Agent of the Northwestern Mutual Life Insurance Co., and Geo. T. Bishop, President of the North Texas Traction Co. It is proposed to extend this road to Ashtabula Harbor, three miles, and rights of way are reported secured.

BRUNSWICK & BIRMINGHAM.—This company has recently purchased the Ocilla & Irwinville line, which runs between these two towns in Georgia, a distance of 12 miles. This road will form a branch with the new line of the Brunswick & Birmingham, which is being built to Ocilla.

BUFFALO, DUNKIRK & WESTERN.—The consolidation of the Dunkirk & Point Gratiot Traction, and the Lake Shore Traction into the above company has been effected. The capital stock of the new road is $300,000. Luther Allen, Jay E. Latimer, J. W. Holcomb and E. B. Allen, Cleveland, Ohio; W. J. Conners, T. G. Avery, C. M. Bushnell and A. J. Myer, Buffalo, N. Y., and F. R. Green, Fredonia, are directors.

GALVESTON, HARRISBURG & SAN ANTONIO.—A bill is now before the Texas Legislature authorizing the purchase by this company of the following lines: The Gulf, West Texas & Pacific, extending from Victoria southwest to Beeville, Texas, 55 miles; the New York, Texas & Mexican, extending from Rosenberg southwest to Cuero, 120 miles, with a branch from Victoria southeast to Port Lavaca, 27 miles; the Galveston, Houston & Northern, extending from Houston southeast to Galveston, 57 miles; and the San Antonio & Gulf, extending from San Antonio east to Stockdale, 38 miles. These lines all belong to the Southern Pacific System.

LOUISVILLE & NASHVILLE.—An issue of $30,000,000 of bonds has been authorized by this company, of which amount $23,000,000 will probably be issued during the current year. The new bonds are to be collateral trust 4 per cent. gold bonds, due 1923, but subject to call after five years at the option of the company. This issue will be secured by a deposit of bonds amounting to $36,640,000. A portion of this new issue will be used to redeem the $7,500,000 collateral 5-20 year 4 per cent. bonds, due April 1, 1903. According to the *Commercial and Financial Chronicle* the collateral for the new bonds is composed of the Louisville & Nashville unified mortgage 4's, including $8,259,000 now in hand, and $8,400,000 pledged for old 5-20 year bonds, due April 1, and $7,981,000 to be received during the current year on various other accounts, a total of $24,640,000; Louisville & Nashville, Paducah & Memphis Division bonds, covering the road from Paducah, Ky., to Memphis, Tenn., 254 miles, $4,779,000; Louisville-Nashville Terminal Co., Nashville, Tenn., $2,500,000; South & North Alabama 5 per cent., $4,221,000, and Pensacola & Atlantic first mortgage, $500,000.

MANHATTAN RY. (NEW YORK).—At a recent meeting of the directors of this company, a quarterly dividend of 1¾ per cent. was declared, and also an additional dividend of 1 per cent. from the surplus earnings of the nine months ending March 31, 1903. (Dec. 5, p. 934.)

MONTFORD & GATINEAU.—This road has been sold to Colonel J. McNaught, of New York, and W. W. Melville, of Boston, both of whom are directors of the Great Northern of Canada. This company was chartered in April, 1890, and runs from St. Sauveur des Montaignes west to Arundel, Que., 33 miles. It will be operated in connection with the Great Northern and several extensions will probably be made in the near future.

UNION PACIFIC.—The gross earnings of this company for the seven months ending Jan. 31, 1903, were $30,926,018, as against $29,387,294 in the previous seven months, an increase of $1,538,724. Operating expenses, including taxes for the same period, show an increase of $1,470,358, during the last seven months. Net earnings an increase of $68,365. The above figures include the earnings, expenses, etc., of the Oregon Short Line, and the Oregon R. R. & Navigation as well as those of the Union Pacific.